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of the

Department of Agriculture

for the

Year 1954/55

(PART II)

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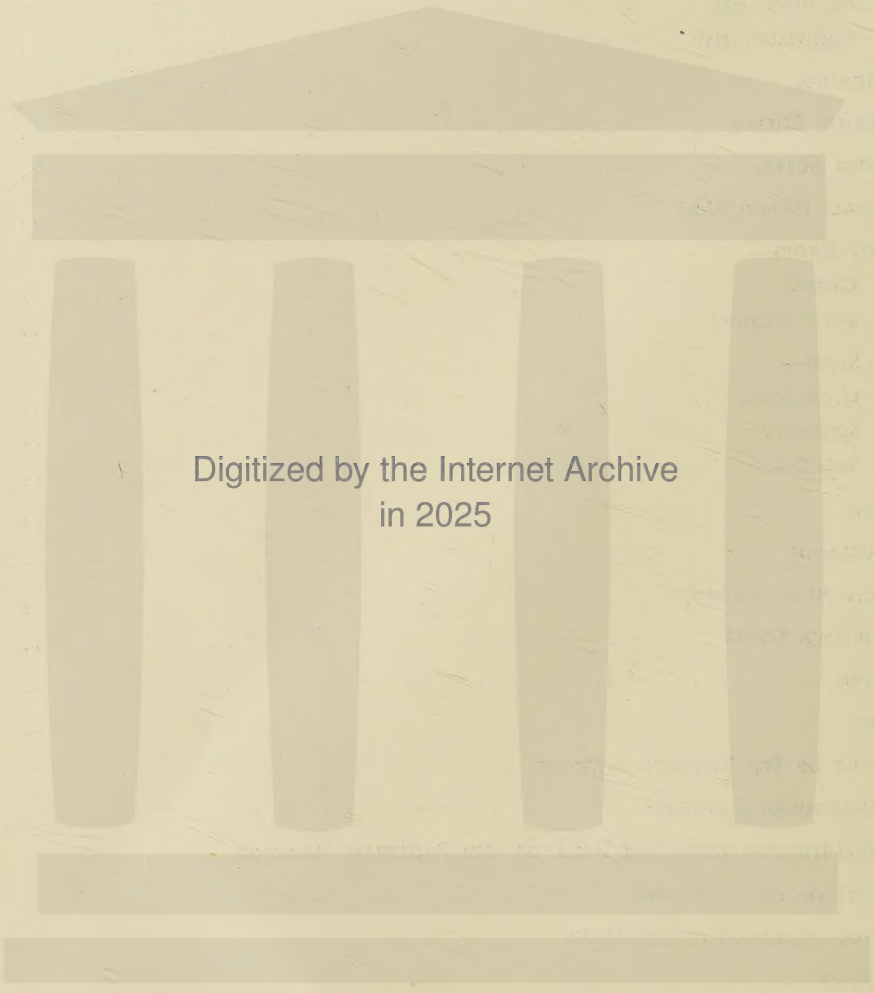

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DEPARTMENT OF AGRICULTURE
ANNUAL REPORT FOR THE YEAR 1954/55
(PART II)

INTRODUCTION

It can at last be claimed that a valuable and fairly comprehensive range of information is emerging from the programme of experimentation which has been a big feature of agricultural policy for the past five or six years.

The original planning of it, and the review and guidance of its progress for the whole Protectorate year by year, is the work of Provincial Agricultural Officers and specialists under the co-ordinating influence of the Chief Agricultural Research Officer and the Director of Agriculture. Farmers' representatives sit on advisory committees for the stations serving their regions and help to ensure that the investigational work is directed to the solution of the practical problems besetting them.

The results already achieved have had a great influence on agricultural policy and production. The outstanding feature has been the paramount importance of early planting of all the major crops, both annual and perennial. The reasons for it are not yet fully understood and are still being investigated. Knowledge on the type of fertilizers required and the rate and time of application is now fairly complete for the more important crops and in consequence their use is spreading from European planters to the better African farmers with highly satisfactory results. With tea the essential features in the successful establishment of new plantings are now well proven and investigation is proceeding into other aspects of subsequent management and in particular the need for shade and the best type of shade to use.

Important information on the pattern of peasant farming is beginning to emerge from longer term trials on rotations and cultural practices. The highly beneficial influence of groundnuts on succeeding crops, particularly maize and dark tobacco, has provided a basis for rotation and greatly enhanced the general value of the crop and stimulated its production. Work on pasture grasses, both for ley and permanent grazing is beginning, to open a way for improvement in animal husbandry.

All this investigational work is of an essentially local character and purpose: it is directed towards the solution of specific problems under Nyasaland conditions. A wider field of investigation is now being opened up on a Federal basis. A Federal Committee, to advise on agricultural research, has been established by the Federal Minister of Agriculture, and its review of fundamental problems and problems common to all three territories should shed still clearer light on the path of agricultural progress.

LIST OF EXPERIMENT STATIONS AND STAFF LIST

The experiment stations in operation during the period under review and the officers who have been in residence are listed below:—

Agricultural Research Station, Lilongwe.

Chief Agricultural Research Officer	S. T. Hoyle
Agricultural Officer (Tobacco)	J. F. Conroy
Agricultural Officer Agronomist)	P. Brown
Plant Breeder	R. T. Ellis
Chemist	R. A. Wood
Senior Agricultural Instructor	W. D. Chona
Senior Agricultural Instructor	Y. J. Kamponda
Field Officer	G. L. Bailey

Tea Experiment Station.

Tea Research Officer	D. L. Downie
Agricultural Officer	D. H. Laycock
Field Officer	G. A. Bridger

Bvumbwe Tung and Experiment Station.

Agricultural Officer	L. J. Foster
Agricultural Chemist	C. V. Cutting
Field Officer	

Tuchila Experiment Station.

Officer In-Charge	G. S. Barker

Makanga Experiment Station.

Officer In Charge	W. G. Plaistow

Mwera Hill Experiment Station.

Officer In-Charge	I. K. Msiska

Lisasadzi Experiment Station.

Officer In Charge	R. F. Cumpston

Mbawa Experiment Station.

Officer In-Charge	F. Higson

Provincial Agricultural Officers.

Southern Province	J. A. Sandys
Central Province	H. W. T. Webb
	A. B. Cormack
Northern Province	R. Smith

Headquarters.

Entomologist	E. L. Drake
Entomologist (Research)	Dr. K. F. Salmond
Ecologist	G. Jackson

MAIZE

Breeding Work

1. INBREEDING.

Inbreeding of the established families of inbred lines was continued. The most advanced now in S6 generation contains a high proportion of very uniform lines, other families in S5 and S4 generations are approaching uniformity, whilst those in S1 are still uneven. Over 1,000 self-pollinations were made within these lines.

The scope of the material being inbred was increased enormously by the introduction of the maize collection made in the 1954 dry season.

2. MAIZE COLLECTION.

With the kind co-operation of Provincial Agricultural Officers and their field staff a sample of three cobs was collected from the area of each African Agricultural Instructor in all parts of the Protectorate where maize is grown. Thus a total of 137 cobs from Northern Province, 808 from the Central Province and 650 from the Southern Province were received. The principal aims of this collection are:—

(*a*) To increase the scope of the material available for breeding.

(*b*) To classify botanically the maize grown in the Protectorate and to find out whether different types are found in different areas. If such differences do occur, to establish whether they correspond to ethnological or ecological boundaries.

(*c*) To gain information on the probable origin and method of entry into the country of the local maize types.

Fourteen different measurements were recorded for each cob received. A row of six plants was grown from each one and the best plant was self-pollinated. Measurements were made of the vegetative characters of the plant and the tassel. A further series of measurements are being made on the selfed cob harvested from each row. A certain number of lines will be studied cytologically.

3. TEST TOP CROSSES.

A further series of top crosses were tested in a yield trial. In all cases Namalenga was the pollen parent and the seed parents were S5, S4 and S3 local inbred lines which had not previously been tested. Because of shortage of space the trial was grown on ground which had borne maize in the previous season and in consequence growth and yields of the top crosses and of the controls were very poor, the mean of the whole being 1,111 lbs. shelled grain per acre as compared with 4,437 lbs. for a similar trial in 1953–54. Families 5 and 18 of the Likuni group (S5) were again represented in the best yielding top crosses and have now over three seasons of test shown themselves to be sources of superior germplasm. The more advanced inbreds gave better yielding top crosses than the less advanced.

TABLE 1

Top crosses average yield (lbs./acre grain)

Likuni inbreds	(S5)	1,294
Research inbreds	(S4)	1,142
Namalenga inbreds	(S3)	1,056
Karonga inbreds	(S3)	1,028
Malwene inbreds	(S3)	952

More top crosses were made with Namalenga as pollen parent and local inbreds as seed parent. These were mainly inbreds in S6, S5 and S4, some being top-crossed for the first time, others which had previously done well being top crossed again for retesting.

4. SINGLE CROSS HYBRIDS.

One hundred and twenty-three of the single cross hybrids which were made in 1953–54 by crosses between combinations of 20 local inbreds, were included in a yield trial (cubic lattice design). The yields of the hybrids arranged themselves in a normal distribution about a mean of

4,941 lbs. of shelled maize per acre. The yields of the seven best hybrids did not differ significantly from Southern Rhodesia Double Hybrid No. 7 which gave 6,587 lbs. Namalenga with 4,737 lbs. was below the mean and local unselected with 4,218 lbs. was near the bottom. These results are very satisfactory and will form a basis for the selection of lines to form double hybrids and synthetic varieties.

A further series of single hybrids were made, 18 inbred lines being crossed in all possible combinations. Of these inbreds, 15 are from local stocks but differing from S6, S5, S4, to S1 and the remaining three are established inbreds from Southern Rhodesia, U.S.A. and Mexico. When these hybrids are tested, information will be forthcoming as to (*a*) whether a greater heterotic effect is obtained in crosses between local and " foreign " germplasm and what is the effect upon the agronomic characters of the hybrid (*b*) at what stage in inbreeding can lines be used to form hybrids.

5. Variety Trials.

Variety trials were conducted at Chitedze, Mbawa, Tuchila, Chitala and Makanga.

TABLE II

Maize Variety Trial

Variety	*Yield of grain (lbs./acre) A.R.S. Chitedze*		*Mbawa*		*Tuchila*		*Chitala*		*Makanga*
Synthetic No. 1	(6)	4,950	(11)	1,508	(6)	2,888	(6)	1,295	(7) 643
Synthetic No. 2	(10)	4,524	(8)	1,799	(5)	2,898	(7)	1,237	(8) 599
Chitala Selection ..	(12)	3,433	(10)	1,144	(10)	2,556	(4)	1,474	(9) 581
Makanga Selection ..	(9)	4,678	(5)	2,247	(3)	2,985	(5)	1,471	(1) 1,241
Namalenga	(7)	4,909	(7)	1,997	(2)	3,324	(8)	1,192	(4) 900
S.R. Hybrid No. 7 ..	(1)	6,577	(1)	2,868	(1)	3,447	(9)	686	(5) 839
Local unselected ..	(11)	4,484	(8)	1,799	(8)	2,756	(3)	1,544	(2) 1,135
Top Cross 26	(4)	4,988	(6)	2,168	(4)	2,953	(1)	1,657	(6) 825
Top Cross 28	(8)	4,905	(2)	2,507	(7)	2,751	(2)	1,519	(3) 964
Double Top Cross 26×28 ..	(5)	4,982	(4)	2,276	(11)	1,900		—	—
Double Top Cross 28×48 ..	(3)	5,706	(3)	2,375	(9)	2,727		—	—
Double Top Cross 26×48 ..	(2)	6,242		—		—		—	—
Cusco	(13)	2,329		—		—		—	—
Least significant difference (P=0.05)		767	..	515	..	455	..	389	.. 191
Mean yield		4,829	..	2,068	..	2,835	..	1,341	.. 858

TABLE III

Maize Variety Trial

Varieties	*Per cent. Establishment* Chitedze	Makanga	Chitala	*Per cent. plants lodged* Chitedze	Makanga	*Aver. No. cobs/plant* Chitedze	*Per cent. cobs with bad tip coverage* Chitedze	*Av. scores H. turcil cum.* Chitedze	*Ratio wt. grain dry wt. stover* Chitedze
Syn. var. No. 1 ..	87	47	65	6	23	0.98	18	1.6	0.52
Syn. var. No. 2 ..	81	53	68	18	17	1.03	10	1.3	0.61
Chitala selection	82	67	86	74	10	1.05	11	2.5	0.75
Makanga selection	87	75	76	45	10	1.05	28	1.9	0.96
Namalenga ..	87	54	61	13	16	0.97	16	1.7	0.66
S.R. hybrid No. 7	86	57	58	54	22	1.06	40	0.8	1.62
Local unselected	86	69	78	9	8	0.95	3	1.3	0.45
Top Cross 26 ..	84	57	75	11	21	1.01	4	1.3	0.55
Top Cross 28 ..	83	56	68	10	17	1.01	6	1.5	0.55
Double Top Cross 26×28 ..	83	—	—	7	—	0.94	13	1.4	0.60
Double Top Cross 28×48 ..	88	—	—	13	—	0.98	30	1.2	0.83
Double Top Cross 26×48 ..	89	—	—	9	—	1.00	4	0.9	0.84
Cusco	70	—	—	19	—	0.80	43	0.7	0.32

The results show in particular the importance of regional adaptation : the Chitedze bred strains have done better at Chitedze than elsewhere, Namalenga was most successful at Tuchila, in the marginal conditions for maize growing at Makanga the local selected and unselected strains outyielded all others and in similar conditions at Chitala the locally selected strain was a success, having failed at all other stations. As is seen from Table III these two last results are at least in part due to superior establishment and standing ability as a reflection of drought resistance.

The Southern Rhodesian Hybrid No. 7 showed itself to be an excellent yielder, especially in good conditions, but lodged very badly and the high proportion of cobs with badly covered tips combined with its soft dent grain gave it very poor keeping quality, especially as most cobs were already infected with weevils (*Calandra oryzae*) when harvested. Namalenga maintained its position as a very good open pollinated variety. In the light of information now obtained from the single cross yield trial—which was not available when the synthetics were made—on the specific combining ability of the component inbreds, the synthetic varieties No. 1 and No. 2 behaved as would be expected. This, however, is not good enough to beat Namalenga and so these particular synthetics have no expectation of use as improved varieties, they will, however, be continued with to give information as to the behaviour of synthetic varieties in advanced generations.

Top crosses No. 26 and No. 28 disappointed as compared with their yields in 1952–53 of 6,492 and 5,725 lbs. grain per acre respectively, it was to be expected therefore that double top cross 26 × 28 should yield no more than its two parents. Its low yield at Tuchila is quite inexplicable.

A very important and encouraging result was the good performance of the double top crosses 26 × 48 and 28 × 48. Both of these double top crosses contain one-quarter of the Southern Rhodesian single hybrid 50 H39 in their make-up and it was anticipated that this would result in a high yield, but it was feared that too many of the quality characteristics of the Southern Rhodesian material would be found as well. This has not proved to be so, as the grain is a hard medium dent and with only a very small proportion of cobs having bad tip coverage and the plants stood very well. A combination of this nature should prove of great value in future work and series of crosses are being made under irrigation at Makanga in the 1955 dry season between selected Southern Rhodesian inbreds and single crosses and the best local inbreds and single crosses. It is hoped that these will be ready in time for testing in the 1955/56 season.

6. Synthetic Varieties.

Four new synthetic varieties were made as under:—

Synthetic variety No. 3.	Basis 7 top crosses grown together in isolation.
Synthetic variety No. 4.	Basis 8 inbred lines grown together in isolation.
Synthetic variety No. 5.	Basis 8 inbred lines combined progressively through single crosses, and double crosses to the quadruple cross, the latter being made under irrigation at Makanga in the 1955 dry season.
Synthetic variety No. 6.	Basis 8 inbred lines grown together in isolation under irrigation at Makanga in the 1955 dry season.

On the basis of the information now available from the single crosses yield trial it is not anticipated that numbers 3, 4 and 5 will be high yielding but they will give information as to the best method of making synthetic varieties. No. 6 is being made using the information available from the single crosses yield trial as to the specific combining ability of its component inbred lines and should be a high yielding synthetic variety.

7. Top Crosses F_1 V F_2 and F_2 V F_3 Yield Trials.

Two trials were conducted to test the yields of top crosses in advanced generations. Results are given in tables below.

TABLE IV

Top Crosses F1 v F2 (lb./Acre Grain)

T. cross A ..	F1 ..	5,608
	F2 ..	5,296
T. cross B ..	F1 ..	5,681
	F2 ..	4,755
T. cross C ..	F1 ..	5,330
	F2 ..	5,288
T. cross D ..	F1 ..	5,189
	F2 ..	3,684
Controls ..	Namalenga	5,197
	S.R.Hy. 7	5,197
	Local ..	4,804
Average all F1 ..	.. ..	5,450
Average all F2 ..	.. ..	4,506
Least Sig. Difference (P=0.05)	.. ..	541

TABLE V

Top Crosses F2 v F3 Trial (lb./Acre Grain)

T. cross E ..	F2 ..	5,206
	F3 ..	5,362
T. cross F ..	F2 ..	4,891
	F3 ..	4,136
T. cross G ..	F2 ..	5,455
	F3 ..	5,189
T. cross H ..	F2 ..	4,547
	F3 ..	4,843
Controls	Namalenga	5,811
	S.R.Hy. 7	5,747
	Local ..	4,592
Average all F2 ..	.. ..	5,024
Average all F3 ..	.. ..	4,882

No significant differences between treatments.

These results confirm genetical theory in that there is a sharp decrease hybrid vigour in the second generation of hybrid but that in the third generation there is no further decline.

8. Miscellaneous.

(*a*) Following a method suggested by Harland the progeny of a number of crosses between vigorous plants selected from a bulk of local maize were tested in a yield trial. As expected, the yields of these crosses were distributed normally but the yield of the best cross fell short by 6 per cent. of that of Namalenga. A further cycle of this method will be applied to the best yielding crosses but it would appear unlikely that selections which are substantially better than Namalenga can be made from the local maize by straight selection without inbreeding. A small collection of maize from Mexico sent by the Rockefeller Foundation grew very well and many crosses were made between the best strains and local material. Nine established inbreds of U.S.A. origin grew very poorly and were particularly susceptible to *Helminthosporium turcicum* but a number of crosses were made between them and local material.

9. Diseases.

(*a*) *Rusts*

There was a general but very mild incidence of the common rust *Puccinia sorghi*. *Puccinia polysora* occured in severe form in the lower altitude areas of the Southern Province being particularly in evidence in the Balaka area and the Lower River where it is also now well established on maize grown during the dry season in *dimba* gardens. At Lilongwe it appeared at about the same time as it had done in the previous two seasons but never progressed and could not be found again after about two weeks.

All reports confirm the findings of previous seasons that the rust did not appear until the cobs had been set even on late planted maize. A series of lines received from E.A.A.F.R.O. in 1953 as possessing resistance to the disease, and crosses between them and local inbred lines were grown at the N.F.C. Rivi Rivi Farm, Balaka where they received a severe test in a heavily infected area. Some of the pure lines and crosses showed a good degree of resistance and cobs were harvested from these plants for further testing. The most promising crosses are being tested for yielding ability and a further series of crosses are to be made on to Makanga selection, a variety adapted to the lower altitudes in which the disease is most severe.

(*b*) *Leaf Blight*

The greater part of the injury in this category was caused by *Helminthosporium turcicum*. Leionss caused by *Diplodia macrospora* were recognized late in the season but no quantitative estimate of the damage caused by this fungus was made. *Helminthosporium turcicum* was reported from all parts of the Protectorate but there is some indication that it was not so severe in the lower altitude areas. The observations reported below were made at Agricultural Research Station, Lilongwe. The disease was first seen on six weeks old maize in a field which had grown maize in the previous season the stover having been used as a mulch between the ridges. Within three weeks all fields on the station were generally infected but this one remained the most heavily infected for the variety Namalenga throughout the season. This indicates that diseased maize stover lying on the surface of the soil provides a source of innoculum which leads to an earlier and more severe attack on maize growing there.

This is also illustrated by the data in Table VI below. The small differences between (*a*) and (*b*) in the table may be due to the fact that the plots were small and adjacent to one another thus allowing for the easy spread of spores. The scores showed that whilst the young plant is susceptible the disease progresses as the plant ages.

TABLE VI

Helminthosporium turcicum. Average scores per plant
(*Scale* 0.5 *to* 5.0, vide *Phytopathology Vol.* 36, 1946)

Treatment	*Variety*	*Scores* 18/1/55	*Scores* 7/2/55
(*a*) Maize following maize, stover used as mulch ..	Namalenga ..	2.0 ..	3.5
(*b*) Maize following maize, stover burnt	,, ..	1.7 ..	3.4
(*c*) Maize following tobacco	,, ..	0.5 ..	1.8

Variety	*Age of plant*	*Scores*
Southern Rhodesia Hybrid 7	13 weeks ..	1.2
Scored 17/2/55	12 ,, ..	1.0
	10 ,, ..	1.0
	8 ,, ..	0.6
	6 ,, ..	0.5
	4 ,, ..	0.4
	2 ,, ..	0.1

All breeding strains were scored and whilst none showed a susceptibility comparable with that of the imported inbreds such as K64 there were none which showed a high degree resistance.

A replicated experiment was conducted in which a comparison was made between the yields of infected plots and those of plots which had been protected by weekly spraying with a fungicide (BLITOX). Rusts were very slight on this experiment and any damage caused may be attributed to *Helminthosporium turcicum*. The control of the disease achieved was only partial and it may thus be considered that the average difference in yield between the protected and unprotected plots of 14 per cent. is a conservative estimate of the damage caused by the disease. The bushel weight of grain from protected plots was with one exception less than that of the unprotected ones indicating that one effect of the disease is to reduce the size of the kernels. There was no significant interaction between varieties and the effect of spraying.

TABLE VII

Trial to assess the effect of incidence of Helminthosporium turcicum on yield of maize
Helminthosporium turcicum average scores per plant
(*Scale* 0.5 *to* 5.0) 25/3/55

	Local unselected	*Namalenga*	*S.R. Hy. 7*	*Local hybrids*	*Top crosses*	*E.A.A.F.R.O. P. polysora resisters*	*All*
Unsprayed ..	1.8	2.2	1.9	1.8	2.0	2.3	2.0
Sprayed	0.8	1.2	0.9	0.8	1.3	1.3	1.1
Yield of grain (lbs. per acre)							
Unsprayed ..	1,529.5	1,802.7	2,187.8	1,847.9	1,596.2	1,227.3	1,698.4
Sprayed	1,786.6	1,974.8	2,290.0	1,947.0	2,214.7	1,387.5	1,933.5
Per cent. Diff. ..	14.5	8.7	4.5	5.5	28.0	11.2	14.0
							L.S.D. 92.0
Bushel weight lbs.							
Unsprayed ..	64.1	63.7	59.6	64.0	62.5	61.9	—
Sprayed	61.7	60.9	58.6	65.0	61.3	61.4	—

(c) Smut

The head or tassel Smut (*Sphacelotheca reiliana*) was of general occurrence and thought to be more prevalent than is usual.

(d) Cob Rots

Comparative figures are not available but it is considered that cob rots were particularly prevalent, this possibly being associated with a high proportion of rainy days during the silking period. The main pathogens were *Fusarium graminearum* and *Diplodia macrospora*, the following were of minor importance:—*Fusarium moniliforme*, *Fusarium moniliforme* variety *subglutinans*, *Nigrospora oryzae*, *Cephalosporium acremonium*.

In one large sample of Namalenga examined 5.9 per cent. of the grain was destroyed. Varietal differences were apparent the local unselected flints being the least badly damaged. Time of planting did not affect the incidence of the disease.

Maize Cultivation Experiments

Viability of Maize Seed from Tips, Middles and Butts of Cobs.

A yield trial was conducted at Agricultural Research Station with seed taken from the 1st inch at the butt, 2nd inch from the butt, 1st inch at the tip, 2nd inch from the tip and seed from the centre section of cobs of Namalenga maize. There was no significant difference in viability or yield and all plots gave a 100 per cent. stand after supplying.

TABLE VIII

Yields of Maize grown from Seed taken from different parts of Namalenga cob

	Germination per cent.			
	In laboratory	*In field at 9 days (before supplying)*	*Wt. of 100 Seed (gms.)*	*Lbs. grain/ acre*
1st inch at tip	89	84	43.6	4,398
2nd inch from tip	97	86	48.6	4,257
Centre of cob	99	83	51.5	4,270
2nd inch from butt	99	78	53.6	4,072
1st inch at butt	98	86	53.3	4,251
Mean	98	84	50.1	4,250

Coef. of variation 13.0% L.S.D. (P=0.05) 469

Fertilizer Trials

(i) Application of High Levels of Phosphate.

At Chitedze and Tuchila an experiment was laid down to test four levels of superphosphate application, nil, 300, 600 and 900 lbs./acre, applied in two ways, as a band beneath the ridge and as dollops on either side of the planting station, half the plots receiving 200 lbs./acre sulphate of ammonia and half receiving none. Results at Chitedze showed that a significant but non-economic response may be obtained from the 300 lbs. dressing but that no further increase may be expected from heavier applications of superphosphate. At Tuchila there was no significant response at all, and this result is confirmed by other experiments carried out at this station in the past.

At Chitedze band placement of the phosphate proved superior to dollop application.

At both stations there was a highly significant response to a 200 lbs./acre dressing of sulphate of ammonia. This response was only economic at Tuchila.

TABLE IX

Response by Maize to High levels of Phosphate and to Nitrogen

	Chitedze		*Tuchila*		
	lbs. grain/acre	*response*	*lbs. grain/acre*	*response*	*Economic response at current price*
Nil	4,921	+409	3,202	—	—
300 lbs./acre supers	5,350	+429**	3,212	+ 10	+ 700 lbs.
600 lbs./acre supers	5,386	+465**	3,608	+ 406	+1,400 lbs.
900 lbs./acre supers	5,585	+664**	3,466	+ 264	+2,100 lbs.
Band placement ..	5,613	+345*	3,497	+ 137	—
Dollop placement ..	5,268	—	3,360	—	—
Nil	5,059	—	2,489	—	—
200 lbs./acre S/A ..	5,563	+504***	4,255	+ 1,766***	+ 800 lbs.
Mean	5,311	—	3,372	—	—
S.D. (P=0.05)					
Phosphate ..	—	370	—	671	—
Placement ..	—	302	—	548	—
Nitrogen	—	262	—	475	—
Coef. of variation ..	6.6%	—	18.5%	—	—

(ii) Comparison of Farmyard Manure and Khola Manure.

At Chitedze, Tuchila and Mbawa a trial was laid down to compare the value of a 5 ton/acre dressing of farmyard manure, made by trampling grass and maize trash in a covered *khola*, against a 5 ton/acre dressing of *khola* manure, collected from a village *khola*, with no litter incorporated and with no roof above. The manure was applied one week or five weeks before planting either in the furrow, before splitting back the ridges, or mixed in a dollop at the planting station. Half the plots received 200 lbs./acre superphosphate, and the other half received none.

TABLE X

Maize responses to Farmyard Manure, Khola Manure and Superphosphate

(*Yields in lbs. grain/acre*)

	Chitedze		*Tuchila*		*Mbawa*	
	Yield/acre	*response*	*Mean yield*	*response*	*Yield/acre*	*response*
Nil	3,589	—	1,605	—	600	—
5 ton/acre F.Y.M.	3,737	+148	1,879	+274*	744	+144*
Nil	3,552	—	1,465	—	545	—
5 ton/acre KH.M.	3,774	+222	2,019	+554***	799	+254**
Applied in band	3,734	—	1,860	—	682	—
Applied in dollop	3,592	—	1,624	—	662	—
Applied 1 week before planting	3,683	—	1,702	—	624	—
Applied 5 weeks before planting	3,643	—	1,782	—	720	—
Nil	3,679	—	1,695	—	584	—
100 lbs./acre superphosphate	3,647	−32	1,789	+94	760	+176*
Mean	3,663	—	1,742	—	672	—
L.S.D. (P=0.05)						
Manures	—	346	—	240	—	133
Times and Method of application	—	400	—	277	—	154
Coef. of variation	12.5%	—	18.3%	—	26.3%	—

At Chitedze there was no significant response to either organic manure, but at Tuchila and Mbawa there were highly significant responses to both, the *khola* manure being more effective than the farmyard manure, weight for weight. It must be realized, however, that much more farmyard manure than *khola* manure can be made with a given number of beasts. It is thought that the quantity of undecayed straw in the farmyard manure may account for its lower effectiveness, weight for weight, than *khola* manure.

There were no differences between times or methods of application. There was a significant response to the 100 lbs./acre superphosphate at Mbawa only.

Last year there was no positive response to farmyard manure or *khola* manure at Chitedze, but significant increases were obtained at Tuchila and Mbawa. *Khola* manure was more effective than farmyard manure last year also at Mbawa.

(iii) Residual Effect of Fertilizers.

A residual trial was planted on the site of a 1953–54 fertilizer trial at Mbawa. In the year of application there were very significant responses to 75 and 150 lbs./acre of sulphate of ammonia, the higher rate being no less efficient than the lower one. Both *khola* manure and farmyard manure at 6 tons/acre gave a highly significant increase while there was no response to superphosphate.

This year there were significant responses to both the organic manures, the *khola* manure giving the greater residual effect. There were no residual effects from the superphosphate or sulphate of ammonia.

TABLE XI

Residual effects of Manures on Maize Yields

(*Yields in lbs./grain per acre*)

Mbawa—manures applied in 1953/54 season

Sulphate of Ammonia		*Superphosphate*		*Organic manures*	
Nil	704	Nil	703	Nil	503
75 lbs./acre	681	100 lbs./acre	774	6 tons khola manure	882***
150 lbs./acre	782	200 lbs./acre	691	6 tons Farmyard Manure	783***
Mean	722	L.S.D. (P=.05) ..	122	Coef. of variation ..	24.8%

(iv) Responses to Nitrogen of Maize Planted at Different Times

A small trial to check last year's results was carried out at Chitedze. Sulphate of ammonia at the rates of nil, 150 lbs./acre and 300 lbs./acre was applied at planting to maize planted on November 16th, December 10th and December 24th. Results confirmed last year's findings that the biggest increases in yield are obtained when nitrogen is applied to an early sown crop, largely due to the greater vigour and yielding capacity of the early planted crop.

TABLE XII

Response to Nitrogen of Maize planted at different times

(*Yields in lbs. grain/acre*)

	Nil S/A	150 *lbs. S/A*			300 *lbs. S/A*			
Chitedze planted	*Yield/acre*	*Yield/acre*	*Response*	*per cent. response*	*Yield/acre*	*Response*	*per cent. response*	*Mean*
Nov. 16th	3,170	4,516	+1,346†	42.5	5,388	+2,218†	70.0	4,358
Dec. 10th ..	2,659	3,869	+1,210†	45.5	3,461	+ 802	30.2	3,330
Dec. 24th ..	1,815	2,387	+ 572	31.5	2,910	1,095	60.3	2,371
Mean ..	2,548	3,591	+1,043†	40.9	3,920	+1,372†	53.8	3,353

L.S.D. P=.05 Marginal means 508 Coef. of variation 11.4%
Centre table 880

Economic Responses at present price levels are for:—

150 lbs./acre sulphate of ammonia— 600 lbs. maize

300 lbs./acre ,, ,, ,, —1,200 lbs. maize.

Economic responses are signified by a dagger (†) in the Table.

(v) Maize Fertilizer Trials on N.A.I.'s Gardens.

There are now results from 60 of these small trials, half of which have had their soil sampled and analysed. Figures from individual trials show coefficients of variation of 20–30 per cent. usually, there being but two replications. When analysed by Provinces, however, the coefficient of variation is reduced to below 20 per cent. In 1953/54 the ten plots from the Central Province showed a highly significant response to 75 lbs./acre suphate of ammonia, and no response to 100 lbs./acre superphosphate. In 1954/55, there were significant responses to both sulphate of ammonia and superphosphate from the ten new plots. In 1953/54, the eight valid plots from the Northern Province and the 17 from the Southern Province both showed as groups very significant responses to the 75 lbs./acre sulphate of ammonia and the 100 lbs./acre superphosphate.

TABLE XIII

Maize Fertilizer trials in N.A.I's. Gardens

(*Mean yields for fertilizer treatments lbs. grain/acre*)

		No. of experiments	*Nil*	*N*	*P*	*NP*	(*L.S.D. P=.05*)
Northern Province	1953/54 ..	8	939	1,554†	1,393†	1,695†	163
Southern Province	1953/54 ..	17	1,564	2,273†	1,992†	2,364†	180
Central Province	1953/54 ..	10	2,197	2,630†	2,237	2,795†	204
Central Province	1954/55 ..	10	1,940	2,420†	2,250†	2,709†	152
Southern Province	1954/55 ..	7	2,008	2,631†	2,101	2,504	183
Northern Province	1954/55 ..	6	875	1,164	1,086	1,348	203

†Economic response to N=320 lbs. maize P=240 lbs. maize

N and P=560 lbs. maize.

It is appreciated that blocking the experiments by Provinces is a very crude way of analysing the results, and as more soil analyses become available, results will be reanalysed on soil type as well as on broad climatic groups. Investigations on figures received so far shows that there may be a correlation between % phosphate response and water soluble silica, and between % phosphate response and % base saturation. There may also be a correlation between % response to nitrogen and the unfertilized yield, which though an awkward criterion to obtain from the majority of farmers, is something to work on in lieu of any suitable soil measurement. This paragraph is of necessity, in the nature of a progress report, and details of the findings will appear as they are confirmed or rejected.

Cultivation Trials

(i) Method of Garden Preparation.

Trials were laid down at Chitedze and Mbawa to test the following factors:—

Maize stover used as mulch v. stover burnt.

Ridging before harvest v. ridging after first rains.

Ridges split v. ridges scuffled and scraped up.

Full-sized ridges made initially v. small ridges made first to be increased in size with subsequent cultivation.

The experiments yielded no significant results except that, at Chitedze, the plots on which the stover was burnt gave a mean yield of 779 lbs. of grain more than those which had had the stover left on the surface as a light mulch. The experiment was too complicated and the plots too small for a cultivation trial.

(ii) Time and Method of Garden Preparation.

These trials at Chitedze, Mbawa and Tuchila were carried on through the rotation. The object is to compare scuffling up the old ridge, against splitting the ridges and against digging in the furrow before splitting the ridges at three times of year, just after harvest, in October and just after the first rains.

Results to date indicate that for maize cultivation there is value in splitting the ridges, though digging in the furrow before splitting would not appear to be worth the extra labour involved. It does not appear to matter when the cultivation is done, so long as adequate ridges can be made.

For groundnut cultivation there have been no significant differences between any of the treatment combinations.

TABLE XIV

Responses to different Times and Method of Garden Preparations

(*Maize and Groundnuts Yield in lbs. mean/acre*)

	Chitedze maize	*Tuchila maize*	*Mbawa maize*	*Mbawa groundnuts*
Scuffling up old ridges	3,857	2,171	1,299	666
Splitting ridge	4,714	2,266	1,004	751
Digging and splitting	4,532	2,303	1,418	739
Just after harvest	4,358	2,111	1,079	674
In October	4,311	2,277	1,305	791
Just after 1st rains	4,434	2,353	1,336	690
L.S.D. P=0.05	459	377	351	130
Coef. of variation	17.6%	19.9%	28.0%	18.1%

(iii) Ridging and Mulching Trial.

This trial was continued at Makanga, testing cultivation on the flat against ridge cultivation with and without boxes or ties. On top of this three levels of mulching were used, nil, light and heavy.

1953/54, a dry year, showed the great benefit to be obtained from all measures taken to conserve moisture. 1954/55, a wet year, shows no significant results at all, not even ill effects which might be expected from water logging on heavily mulched or box ridged plots on flat land.

TABLE XV

Effects of Ridging and Mulching on Maize

(*Yields in lbs. grain/acre*)

	1953/54		1954/55	
	Makanga	*Ngabu*	*Makanga*	*Tuchila*
Flat	2,297	436	1,653	904
Ridge	3,306	531	1,592	1,474
Ridge and Box	4,406	474	1,634	1,463
No mulch	2,063	402	1,640	1,198
Light mulch	3,615	460	1,583	1,367
Heavy mulch	4,331	579	1,557	1,275
Mean	3,336	480	1,626	1,280
L.S.D. P=.05	219	48	139	397
Coef. of variation	33.3%	23.6%	12.7%	32.2%
Rainfall	14.85″	—	28.77″	35.91″
Evaporation	31.45″	—	20.98″	—
	Dec.–May	—	Dec.–March	—

These experiments have not shown much accuracy, but there appears to be evidence on yield alone in favour of ridging as opposed to flat cultivation under these conditions. From the point of view of soil conservation, ridging and boxing have everything to be said for them. Mulching is a more doubtful undertaking, owing to the extra labour involved in laying a heavy mulch.

(iv) Weed Control Experiment.

An experiment was carried out at Chitedze, to test early weeding (three weeks after planting) against weeding ten days later, one weeding only before banking up in February against two weedings before banking up in February, and no fertilizer against 100 lbs./acre sulphate of ammonia applied three weeks from planting. It showed a very significant response to nitrogen of 587 lbs. grain, but no response to the weeding treatments or interaction between weeding and fertilizer treatments. Weeds were evidently not allowed to grow sufficiently rampant.

SORGHUMS

Variety Trials.

There were variety observation plots planted at Chitedze, Tuchila, Makanga and Mbawa, At Mbawa the sorghum failed as it has done two years out of three. In the past, sorghums had been planted at Mbawa after Christmas and as late as the first week in January, and it is hoped that planting at the beginning of December will give a more reliable crop. At Makanga yields were very poor, though the crop was planted on December 10th. Here bird damage was severe especially on the later varieties. The highest yielders at each station were as follows:—

TABLE XVI

Yields of Sorghum Varieties

(*lbs. grain/acre*)

Chitedze			*Tuchila*			*Makanga*		
Variety	*Type*	*Yield*	*Variety*	*Type*	*Yield*	*Variety*	*Type*	*Yield*
T/S 14*	M.M.C.	2,360	S/S 28*	M.M.C.	1,316	S/S 10**	D.E.C.	310
U/S 12**	M.M.C.	2,328	NR/S 2*	T.L. ?	1,137	S/S 40	D.E.C.	282
T/S 18	D.E.C.	2,106	NR/S 6	T.L. ?	866	T/S 19	D.E.C.	280
U/S 11*	M.M.C.	1,593	T/S 10*	T.L.O.	741	T/S 23*	D.E.C.	280
N/S 5	M.M.O.	1,420	NR/S 5		508	—	—	—
BC. 85 UT*	D.E.C.	1,320	U/S 12**	M.M.C.	576	—	—	—
N/S 3	T.L.O.	1,240	T/S 26*	D.E.C.	480	—	—	—
N/S 2	T.L.O.	1,232	—	—	—	—	—	—
U/S 16**	M.M.C.	1,155	—	—	—	—	—	—
U/S 2*	M.M.C.	1,030	—	—	—	—	—	—

SS28 M.M.C.
SS46 M.M.C. } have in the past yielded well at Tuchila and Makanga

T=Tall
M=Medium height
D=Dwarf

E=Early maturing
M=Medium
L=Late maturing

O=Open head
C=Chub head

*Have shown promise in former years.

Yields have varied widely from year to year in these observation plots, and the time has come for replicated trials of those varieties which have shown promise in the categories early, medium and late maturing.

BULRUSH MILLET

The West Coast varieties planted at Misanje in 1953/54 were again planted in observation plots at Makanga in 1954/55. Agreement between results from the two stations is poor, but yields of over 1,200 lbs./acre grain appear to be obtainable.

A plot of Hedge Hog Bulrush Millet planted at Chitedze for bulking seed produced 800 lbs. grain/acre.

FINGER MILLET—ELEUSINE

A fertilizer trial was laid out on finger millet grown at Mbawa. The treatments included nil, 200 lbs./acre sulphate of ammonia, 200 lbs./acre superphosphate and 200 lbs./acre muriate of potash in all combinations, applied before planting in a drill along the top of the ridge. There were significant responses to N,P and K, but no interactions. Growth was very uneven, due in part to the seed being washed out of the very sandy ridges.

TABLE XVII

Responses of Finger Millet to Fertilizers

(*Yields lbs. grain/acre*)

Treatment	*Yield*	*Response*
Nil	500	—
200 lbs./acre Sulp./Ammonia	966	+466
Nil	579	—
200 lbs./acre superphosphate	887	+308
Nil	604	—
200 lbs./acre muriate/potash	862	+258
Mean	733	—
L.S.D. P=.05	184	Coef. of var. 34%

A quarter acre plot of local seed sown at the Tung Station yielded 933 lbs. seed/acre unfertilized

CEREALS

Wheat

Varieties of Summer Wheat from Kenya were again sown at Mwera Hill on three dates. Single plots only were sown. Figures do not correspond well with those of the last two years except in that it does not pay to plant later than January.

TABLE XVIII

Time of Sowing Varieties of Summer Wheat

(*Yields lbs./acre grain*)

Variety	*184*	*294*	*318*	*337*	*360*	*Mean*
Sown 15/12/54	375	250	250	250	291	283
Sown 15/ 1/55	500	458	500	708	458	525
Sown 15/ 2/55	nil	nil	nil	nil	nil	nil

Variety 337 appears to give the highest yields if planted at the right time, but 184 and 318 are more reliable.

Rice

A number of experiments were put out at Sombani, but owing to the considerable press of work in developing the area with limited staff, the experimental conditions were not of the best.

Varieties

In the observation plots of 100 sq. yards area, the highest yield recorded was 6,590 lbs. paddy/acre from 1/158. Others yielding more than 4,000 lbs./acre were 1/232 (5,200 lbs.), Kilmbero (4,908 lbs.), 9/82 (4,675 lbs.), 1/196 (4,608 lbs.), Demerara Local (4,550 lbs.), 1/355 (4,419 lbs.), 1/123 (4,385 lbs.), Maji Maji (4,308 lbs.), Chibica (4,278 lbs.), Kahogo (4,211 lbs.), 1/220 (4,201 lbs.), 1/133 (4,066 lbs.). Faya yielded 3,872 lbs./acre.

Nitrogen Trial

Nitrogen was applied at the rates of nil, 200 lbs./acre, 400 lbs./acre and 600 lbs./acre sulphate of ammonia.

TABLE XIX

Response of Rice to Sulphate of Ammonia

(*Yield lbs./acre paddy*)

Treatment	*Yield*	*Response*
Nil	3,281	—
200 lbs. Sulphate/Ammonia	3,634	+353
400 lbs. ,, ,,	3,879	+538
600 lbs. ,, ,,	3,189	+908
Mean	3,731	
L.S.D. (P=0.05)	470	Coef. of variation 7.9%

The heavy dressing of nitrogen failed to have any effect on yellowing though significant increases in yield were obtained. None of these increases were economic at present price levels.

An exploratory fertilizer trial using 300 lbs./acre sulphate of ammonia, 300 lbs./acre supers, 100 lbs./acre muriate of potash, 6 tons/acre dung and 150 lbs. of magnesium sulphate failed to give any significant response.

ROOT CROPS

(*a*) Cassava

(i) Variety Trials

As with all single plot observations, yields from Chitedze, Tuchila and Kota Kota are difficult to correlate, particularly as plots are small and yields from individual plants vary enormously. Only one year's weighings are to hand, and from these the following observations can be made. Of the varieties originally imported from Amani only six seem to give yields comparable to the local types.

These are numbers 4,332/2 (T3), C.117 (T5), 4,697/4 (T11), 46,106/26 (T14), 46,106/27 (T15), T.206 (T18). They all show symptoms of mosaic especially 4,332/2 (T3), but appear to grow away from the disease. In this respect they were little better than the most resistant Nyasaland varieties. The most recent importations grown at Tuchila have not yet been harvested at maturity, but the following show promise—4705/A31, Aspin Valencia, Msitu and 4763/16, especially the first. The Amani varieties yield no better than local varieties.

(ii) Time and Method of Planting.

At Chitedze cuttings of two sizes (3 nodes and 8 nodes) and of two local varieties, were planted upright and at an angle on two different dates (December 1953 and February 1954). The coefficient of variation for the experiment was very high, due to the extreme variability in plant yields, but there were a number of significant effects.

TABLE XI

Effects of Time and Method of Planting Cassava

Treatment	*Yield/acre short tons*	*Yield/plant lbs.*	*Per cent stand*
To planted December, 1953	12.3	17.1	74.8
T1 planted February, 1954	4.9	11.8	45.0
Effect	— 7.4***	— 5.3*	— 29.8***
N0 3 Node cuttings	6.5	16.0	42.2
N1 8 Node cuttings	10.7	13.0	77.6
Effect	4.2**	— 3.0	33.5***
V0 Kawalika	8.7	16.2	57.0
V1 Maonga	8.4	12.8	62.8
Effect	0.3	— 3.5	5.8
Mean	8.6	14.5	59.9
L.S.D. P=.05	3.2	4.7	8.8
Coeff. of variation	48.1%	43.9%	19.8%

The main differences were obvious before harvest. Later planted plots were stunted and very uneven, and the stand was much poorer on the plots planted with 3 node cuttings than on those planted with 8 node cuttings. Late planting decreases the stand, the yield per plant and the size of the roots, whereas cutting size affects the yield through the stand only. There was little difference between the varieties.

(*b*) Sweet Potatoes

The eight varieties tried last year at Chitedze were again planted, and the following appear to be the best varieties.

Mkokabwato yielded 5.6 tons/acre of tubers which cook well and keep fairly well—sprouting slightly after three months in a light store.

Malamulo yielded 4.8 tons/acre of good tubers which keep quite well.

Kamciputo yielded 3.6 tons/acre of very palatable tubers which keep at least three months in a light store without sprouting or rotting.

OIL SEEDS

Groundnuts

(i) Variety Trials.

There emerges a fairly definite pattern in the yields of groundnut varieties.

At Mbawa the late maturing types invariably produce the highest yields, and of these Chimbwila, U/A 35 and U/A 39 among the runners and S/A 4 Jur among the semi-bunch types may be expected to average 1,000 lbs. of shelled nuts per acre. The best early bunch type U/A 18 averages but 700 lbs./acre.

At Chitedze both late and early varieties have produced high yields, depending upon the weather. Usually the early varieties do best, though the position was reversed in 1953. It has not been possible yet to correlate this phenomenon with any specific weather factor. The best of the bunch early types are Barberton and Gambia, averaging in the past about 1,800 lbs. shelled nuts to the acre, with Natal Common averaging 1,600 lbs. These varieties are very similar having small nuts which are very tedious to shell by hand, but the bunch varieties U/A 8 and U/A 18 average about 1,500 lbs. and have large nuts more easily hand-shelled. Of the late maturing dormant bunch types Mwitunde has averaged about 1,700 lbs. per acre. Other early and late bunch types with large nuts have shown promise in observation plots and these will be compared with the above-mentioned this coming season.

Of the late runner varieties U/A 39 (1,900 lbs.) and SA/A 6 (1,750 lbs.) are the best at Chitedze, the local nut Chimbwila averaging 1,200 lbs. nuts per acre. U/A 1 and U/A 28 also yield well but are not thought very palatable.

At Tuchila, Chitala and Makanga, the early varieties invariably do best, though at Makanga yields of only 600 lbs. per acre may be expected. Gambia and Natal Common again do well, but U/A 18, U/A 40, U/A 41 and SA/A 2 Masambika, having large nuts more easily shelled, do just as well, giving about 1,600 lbs. at Tuchila and 1,200 lbs. at Chitala. Mwitunde yields 950 lbs. at Tuchila and 800 at Chitala, while Chimbwila yields 1,000 lbs. and 750 lbs. respectively.

Yields of groundnuts this year have been poor at all stations.

(ii) Time of Planting and Lifting.

The 1953/54 trial was repeated this year at Chitedze with the same results. It pays to plant early and it pays to lift Spanish Bunch and other non-dormant varieties at the correct time (100 days from planting).

TABLE XX

Effect of Time of Planting

(*Yields in lbs./acre shelled nuts*)

	Spanish bunch	*Mwitunde*
Planted 18/11/54	1,262 ..	1,231
Planted 10/12/54	907 ..	1,037
Planted 28/12/54	507 ..	641
L.S.D. P=.05	139 ..	198

TABLE XXI

Yield in Relation to Maturity

(*Yields in lbs./acre shelled nuts*)

Spanish Bunch			*Mwitunde*		
Lifted after 90 days	..	872	Lifted after 120 days	..	924
„ „ 100 „	..	1,097	„ „ 130 „	..	984
„ „ 110 „	..	771	„ „ 140 „	..	1,004
„ „ 120 „	..	827	„ „ 150 „	..	968
L.S.D. P=.05 ..	..	79	.. .. ..	..	95

(iii). Control of Cercospora Leaf Spot.

The 1953/54 experiment was repeated this year at Chitedze using Blitane instead of Fernide as the non-copper spray. Perenox was sprayed at the rate of 2½ lbs. per acre in 100 gallons of water and the Blitane at 1½ lbs. per acre in 100 gallons of water. Plots were sprayed every three weeks starting on December 29th and ending on March 7th. Complete control was not obtained with either spray but the Perenox was more effective than the Blitane. Gambia was much more heavily attacked by the disease than Mwitunde 53 days from planting, and there is a significant negative correlation (r=—.69) between the plot yields of Gambia and the number of leaflets attacked at that date. There is no such correlation with Mwitunde. Thus Gambia would appear to suffer loss of yield more readily than Mwitunde and would thus benefit more from any control that a spray might achieve. Indeed Blitane does increase the yield of Gambia but not of Mwitunde.

TABLE XXII

Effect of Spraying to control Cercospora

(*Yields in lbs./acre shelled nuts*)

Spray	*Gambia*		*Mwitunde*		*Mean*
	Per cent. leaflet attack	*Yield*	*Per cent. leaflet attack*	*Yield*	*Yield/acre*
	19/2/55		19/2/55		
No spray	73	1,337	49	1,137	1,237
Perenox	64	1,544	36	1,499	1,522*
Blitane	65	1,451	44	1,121	1,286
				L.S.D.	199

Sunflower

At Chitedze isolation plots were planted and heads selected to try to purify the types on hand. Observation plots of the unselected seed were also planted in early January. Kampala variety, which did so well last year was disappointing this year, and produced predominantly white seeds. It is being rigorously selected for its characteristic striping. Giant Black gave 1,307 lbs. seed, Giant White 1,102 lbs. and Black Mars 1,038 lbs. per acre.

At Tuchila three varieties were planted early on 27th November (harvested 30th March) and late on 18th December (harvested 25th April). The early planting yielded a mean 1,045 lbs./acre against 537 lbs./acre from the late one.

At both Stations seeds were poorly filled this year, though the heads were large.

Soya Beans

(i) Varieties.

A variety trial was carried out at Chitedze and the Tung Station and single plot observations on varieties at Chitedze, Mbawa and Tuchila. Yields were very good.

TABLE XXIII

Yields of Soya Bean Varieties

(*lbs. clean seed per acre*)

Variety	*Chitedze*	*Tuchila*	*Tung Station*	*Mbawa*
Pelican	1,165	1,814	2,951	1,250
Light speckled	1,140	1,602	2,543	1,400
B.C.A. Yellow	1,107	893	—	—
Glycine 317	1,090	888	—	1,750
Glycine 29	1,078	1,089	2,445	1,250
Potchefstroom	1,063	—	—	1,900
Hernon local	1,059	1,397	2,775	1,400
Tung Station Yellow	1,051	—	2,877	—
Avoyelles	1,051	1,113	2,539	—
S. 100	1,000	1,474	2,908	1,450
Hernon 107	983	—	—	—
C.N.S.	982	1,230	2,416	1,150
Volstate	980	1,174	3,140	1,300
Ogden	940	1,590	2,613	1,250
Yellow Kedale	845	1,389	—	1,650
MK—CNS—24	743	—	—	—
Yerlando	(417)	719	—	800
Blyvoor	(115)	327	—	—
Seminole	(710)	697	—	1,150
Hernon 279	(1,061)	1,501	3,066	1,600
Peruvian Yellow	(448)	—	2,820	—
Tung Station Black	(587)	—	2,820	—
Benares	(269)	—	2,325	—
Hernon 237	(330)	—	2,207	—
Mix 28 E.B.	(550)	—	2,192	—
Malaya	(303)	—	1,954	—
R.184	(600)	—	—	800
Mean	1,017	1,184	2,623	—
L.S.D.	358	—	470	—

These are mostly medium or long term varieties. Short term dwarf varieties observed at Chitedze matured during the late rains and yielded at best 500 lbs. of seed per acre.

(ii) Method of Cultivation

At the Tung Station a trial was laid down to test two times of planting and two spacings with Nil and 200 lbs. of Superphosphate and with inoculated and uninoculated seed.

TABLE XXIV

Effects of Cultivation practices on Soya Beans

(*Yields lbs. clean seed/acre*)

Treatment	*Early planting Nov. 11th*	*Late planting Dec. 2nd*	*Mean*
1 row/ridge 6″ apart	3,243	2,564	2,904
2 rows/ridge in row	3,523	3,030	3,277
Effect	+ 280	+ 466	+ 373**
Nil	3,307	2,916	3,112
200 lbs./acre supers.	3,460	2,679	3,070
Effect	+ 153	— 237	— 42
Not inoculated	3,224	2,611	2,918
Inoculated	3,543	2,984	3,264
Effect	+ 319	+ 373	+ 346*
Mean (times of planting)	3,383	2,797	3,090
Effect (times of planting)	— 586***	—	—

L.S.D. P=.05 266
Coef. of Varn. 11.4%

Early planting again proved to be of great benefit as did seed inoculation and two row planting.

At Chitedze a variety and spacing trial showed no significant differences between the following spacings:—

	Mean plant count	*Mean yield/acre*
(*a*) 3′ ridges, 2 rows per ridge one seed every 3″ in row ..	60,250	1,251
(*b*) 3′ ridges, 3 rows per ridge 2 seeds every 9″ in row ..	68,200	1,336
(*c*) Flat, rows spaced alternately 14″ & 28″, one seed every 3″ in row	57,550	1,159
L.S.D. P=.05 ..		146

Method (*b*) is the easiest to plant by hand, and method (*c*) by tractor. Half the blocks were planted with inoculated seed, but this produced no noticeable effect.

PULSES

Beans

Tenth acre plots grown at Chitedze to maintain seed stocks gave the following yields:

Canadian Wonder	304 lbs./acre
Jandalala	444 lbs./acre.

There was no beetle attack and the crop was free from disease. The crop was planted like a groundnut crop, three rows per ridge and 9 ins. apart in the row.

At Mbawa the local selection yielded about 300 lbs./acre of seed.

White Haricots have yielded no more than 300 lbs. per acre at Mbawa and the Tung Station.

Tepary Beans

A time of planting and spacing observation at Chitedze showed that the highest yields came from the earliest plantings on 2nd and 12th December, but these came to harvest in the middle of the rainy season, making harvest difficult and loss through mould severe. Christmas would seem to be the optimum time for planting so long as the rains do not continue into April. The crop matures in about 90 days. The optimum spacing would appear to be similar to that for groundnuts, two rows per ridge and two seeds planted every 6–9 ins. in the row. The mean yield per acre this year was but 250 lbs. seed.

Cow Peas

Cowpea varieties planted at Chitedze were destroyed by a fungus disease thought to be due to *Ascochyta* sp. The lesions on the leaves look rather like those of *Alternaria* on tobacco. One experiment planted on November 30th grew well until mid-January when the attack started. Mwazisi, Nseura and Tanganyika managed to yield over 150 lbs. seed, the other varieties failed. Observation plots planted on December 15th produced nothing.

At Tuchila, the varieties Blantyre, Tanganyika and Nseura planted in November yielded over 750 lbs. seed per acre. Mwazisi was not planted. A crop sown in late December failed owing to a "shot hole" disease

The four varieties mentioned appear to be the best but Dr. Saunders and Turiana may be of interest, being somewhat resistant to the *Ascochyta* disease though maturing rather late.

GRASSLANDS

(i) Varieties.

Rhodes grass continues to be the main rotation grass used at Chitedze but *Panicum Makarikari* is gaining favour and has been accepted as the main rotation grass at Mbawa. It does not spread as rapidly but its cuttings take well, it is very palatable and it withstands drought better than Rhodes grass. *Cenchrus Ciliaris* (African foxtail) varieties prove difficult to establish from cuttings as they do not spread. Seed is being collected for seeding trials, for the grass promises to be a good hay

type with some dry season growth. *Setaria Sphacelata* (Bua) has also proved of value if it can be established cheaply by machinery, its seed being heavily attacked by disease and its growth tufty. *Paspalum* species are establishing themselves, but spread slowly and need to be planted out at 1ft. × 1ft. spacing or sown from seed. Less coarse varieties of Star grass are being bulked for trial, and selections of Rhodes grass made for hay and grazing types with early and late flowering characteristics. Weed competition is the most important problem in establishing all varieties which do not very rapidly form a cover, *i.e.* all except Rhodes grass, Star grass and Makarikari. The Nchisi strain of Guinea grass shows promise as a silage grass, more easily manageable than Elephant grass. The latter is proving to be most valuable for its supply of dry season grazing, which has enabled the young stock on the station to carry through the dry season without check.

(ii) Fertilizers.

Fertilizer trials were carried out on Rhodes grass at Chitedze and the Tung Station for the second year on the same site.

TABLE XXV

Chitedze—High levels of N. and P. Third Harvest year and Second year of Experiment. Response of Rhodes Grass to Fertilizer

(*Yields in short tons hay/acre*)

Treatment	*Cost of fertilizer* £ s d	*Yield*	*Cost/ton hay made*	*Response*	*Cost/ton response*
Nil	*Nil*	2.62	*Nil*	—	—
200 lbs./acre S/A	3 7 6	3.15	21s	.53	127s
400 lbs./acre S/A	6 15 0	6.17	22s	3.55**	38s
600 lbs./acre S/A	10 2 6	8.30	24s	5.68***	36s
800 lbs./acre S/A	13 10 0	9.31	29s	6.69***	40s
1,000 lbs./acre S/A	16 17 6	9.44	35s	6.82***	49s
1,200 lbs./acre S/A	20 5 0	9.72	41s	7.10***	57s
1,200 lbs./acre Nitromonocal	15 18 0	8.19	39s	5.57***	57s
Nil	—	6.59	—	—	—
300 lbs./acre supers	2 18 0	7.63	7s–6d	1.04	56s
Mean		7.11			
L.S.D. P=.05		2.23	Coef. variation		10.9%

All fertilizers were applied on November 27th and one cut taken in April.

TUNG STATION. High levels of N—Second year of Experiment

Treatments	*Cost of fertilizers* £ s d	*Yield*	*Cost/ton made hay*	*Response*	*Cost/ton response*
Control	Nil	2.64	—	—	—
100 lbs./acre S/A every 3 months (400 lbs.)	6 15 0	7.36	18s	4.72	31s
200 lbs./acre S/A every 3 months (800 lbs.)	13 10 0	9.21	29s	6.57	41s
300 lbs./acre S/A every 3 months (1,200 lbs.)	20 5 0	11.87	34s	9.23	44s
100 lbs./acre S/A every 3 months (1,200 lbs.)	20 5 0	11.28	36s	8.64	47s
100 lbs./acre nitromonocal every 3 months (400 lbs.)	5 6 0	6.02	18s–6d	3.38	31s
200 lbs./acre nitromonocal every 3 months (800 lbs.)	10 12 0	7.14	30s	4.50	47s
300 lbs./acre nitromonocal every 3 months (1,200 lbs.)	15 18 0	8.01	40s	5.37	59s
100 lbs./acre nitromonocal every 3 months (1,200 lbs.)	15 18 0	8.83	36s	6.19	51s
L.S.D.		0.9	Coef. of Varn.		10.5%

Cost of S/A taken as £33–15s per short ton.
Cost of Nitromonocal taken as £26–10s per short ton.
Cost of Superphosphate taken as £19–10s.

Chitedze—Low levels of N—First Harvest year of ley

Treatments	*Cost of fertilizer* £ s d	*Yield*	*Cost/ton hay made*	*Response*	*Cost/ton response*
Control	Nil	5.06	—	—	—
100 lbs./acre S/A	1 3 9	5.85	4s	.79	30s
150 lbs./acre S/A	1 15 6	6.66	5s	1.60	22s
200 lbs./acre S/A	3 7 6	7.18	9s	2.12	32s
300 lbs./acre S/A	5 1 3	6.90	14s	1.84	55s
600 lbs./acre S/A	10 2 6	8.28	24s	3.22	65s
Mean		6.66			
L.S.D.		1.14	Coef. of variation 16.6%		

All fertilizer applied end of November, 1954, and one out taken at the end of March.

It would appear from these figures that a 600 lb. dressing of sulphate of ammonia would yield 8–9 tons of hay whatever the age and unfertilized yield of the pasture, and would cost 20s–25s per ton of hay made. A 300 lb. dressing would yield about 7 tons of hay and cost 14s. The unfertilized yield of Rhodes grass pastures decrease with age, and responses to fertilizer likewise increase up to a certain age. The three year old ley at Chitedze seems to be nearing the limit of its economic life. That at Tuchila responds better, possibly because of better rainfall distribution. Unless it is necessary to produce large yields of hay or silage from a very limited acreage of Rhodes grass, one would hesitate in recommending dressings of over 300 lbs. per acre sulphate of ammonia on a field scale. Nitromonocal does not give such big responses as sulphate of ammonia, but the cost per ton of hay made compares favourably this year and it does not make the soil so acid. In 1953/54 a dry year (31.1″ at Tung Station) sulphate of ammonia was much the more effective fertilizer, but the difference is far less marked in a year of high rainfall such as 1954/55 (54.5″ at Tung Station). It is reported from the Tung Station that the 400 lb. application of sulphate of ammonia reduced the pH of the Rhodes grass pasture from 6.1 to 4.8, while 400 lbs. of Nitromonocal reduced it from 6.1 to 6.0 only. If the magnitude of this difference is confirmed, and prices remain as they are, there will be much to be said for making routine nitrogen applications to pastures in the form of Nitromonocal or nitrate of soda.

Elephant grass spacing trial at Chitedze and Tuchila confirm that close spacing increases yield but that there is little significant difference between 3′ × 3′, 3′ × 6′ and 6′ × 6′ spacings. 3′ × 9′ spacing is not significantly lower at Chitedze but is so at Tuchila.

TABLE XXVI

Effect of spacing on Elephant Grass yields

(*Short tons green material/acre*)

Spacing	*Chitedze 2 cuts 2nd harvest year*	*Tuchila 2 cuts 1st harvest year*
3′ × 3′	—	40.16
3′ × 6′	32.8	38.88
6′ × 6′	35.2	29.55
3′ × 9′	30.8	24.60
3′ × 12′	23.0	—
3′ × 15′	19.6	—
Mean	27.7	33.38
L.S.D.	3.4	9.51
Coef. of variation	16.9%	23.2%

If planted for grazing or for cutting and cultivation by hand 3′ × 3′ or 3′ × 6′ spacing is advisable to swamp out weed growth. If tractors are available for cultivation, 3′ × 8′ spacing allows passage to the machines. Tractor mowers will not cut a two-year old stand over 8 feet tall—they clog. For tractor mowing the stems must never be allowed to grow too thick and the grass should be grazed or cut at 4 feet high and cut right down.

EXTRACT FROM AGRICULTURAL CHEMIST'S REPORT

Soil samples were taken and grass analysed from the fertilizer experiment at Bvumbwe. The soil samples were taken after the rains were over and the grasses were sampled for analysis at the end of the dry season and during the rains. The results are given in the two following tables.

Fertilizer treatment	*Star Grass*			*Rhodes Grass*		
	Dry season 30/10 *per cent N*	*Wet season* 31/12 *per cent. N*	*Yield* 1953/4 *tons/acre*	*Dry season* 30/10 *per cent. N*	*Wet season* 31/12 *per cent. N*	*Yield* 1953/4
0.	0.73 0.98	1.04	3.0	1.18	0.82	2.6
S/A*	1.71 1.57	0.87	8.2	1.0	1.58	6.0
N/A*	1.04	1.1	5.4	1.21	1.28	4.6

* 100 lbs. every 3 months.

The figures for nitrogen content do not always follow the same pattern—although the nitrogen content on a weight basis must be considered in conjunction with the total yield of grass obtained, since with higher yield, the nitrogen taken up is spread over a larger bulk of grass.

Tung Station Pastures—Top Soil Samples

Star grass	*Munsell soil colour*	*pH*	*Texture*			*B.E.C.*	*%*	*K*	*P (p.p.m.)*		*%*	*%*	*C/N*
			% sand	*% silt*	*% clay*	*me %*	*base sat.*	*me %*	*avail.*	*reserves*	*C*	*N*	*ratio*
Nil ..	10 yr. 3/3	6.3	76	10	14	13.9	88	1.28	130	216	2.3	0.20	11.5
S/A ..	,, 3/4	5.5	72	14	11	10.1	80	1.16	55	143	1.7	0.15	11.3
N/A ..	,, 3/4	5.7	75	14	17	6.9	78	0.6	44	137	1.0	0.10	10.0
Rhodes grass													
Nil ..	5 yr. 3/3	6.1	74	17	14	7.9	85	0.75	130	269	1.2	0.13	10.9
S/A ..	,, 4/3	4.9	66	14	17	9.7	70	0.62	130	260	1.7	0.17	10.0
N/A ..	,, 3/3	6.0	78	17	11	9.0	88	1.06	130	300	1.4	0.15	9.8

S/A=sulphate of ammonia. N/A=nitrammonical.

From these results it is clear that the fertilizer applications are not reflected in the nitrogen contents of the soil, which are more related to the total content of organic matter. It appears therefore that the fertilizer is either consumed by the grass, or is leached below the top soil zone. It is interesting to note that the nitrogen does not seem to have increased the organic matter in the soil, due to greater fine root development, as has been found elsewhere. It must, however, be noted that no samples of these soils from the specific plots were examined before the fertilizer applications.

The main point to note from the soils data is the appreciable reduction of the pH of the soil due to application of ammonium-sulphate from 6.3 to 5.5 on Star grass, and from 6.1 to 4.9 on Rhodes grass. The corresponding figures for nitrammonical were 6.3 to 5.7, and 6.1 to 6.0.

6. Experimental Stations, etc.

Fifty-six samples were examined from Tuchila, 22 from Makanga and 37 from gardens of

N.A.I's. where experiments were in progress. It was interesting to note the relationship between the potassium status of the Makanga soils, and their content of silt and clay viz:—

Clay ..	8 ..	11 ..	14 ..	17 ..	20 ..	22 ..	23 ..	25
Silt ..	12 ..	17 ..	23 ..	24 ..	27 ..	26 ..	33 ..	30
K ..	1.18 ..	1.30 ..	1.93 ..	2.05 ..	2.05 ..	2.24 ..	3.03 ..	2.14

ROTATION EXPERIMENTS

Work on the long term rotation experiments continues at various stations. It is too early yet to see the effects of whole rotations, but one can obtain mean yields for maize following various crops and fallows.

TABLE XXVII

Rotation Experiment No. 1, Maize after various Crops

(*Mean Yields in lbs. grain per acre*)

Maize after	*Chitedze* 2nd year	*Lisasadzi* 3rd year	*Tuchila* 2nd year	*Makanga* 3rd year	*Mbawa* 3rd year
1 Maize crop ..	1,479 (31)	353 (14)	852 (31)	1,205 (14)	486 (14)
1 Maize crop + 100 lbs. S/Ammonia ..	2,131 (31)	675 (14)	1,469 (31)	1,265 (14)	1,393 (14)
2 Maize crops ..	—	291 (17)	—	973 (17)	513 (17)
2 Maize crops + 100 lbs. S/Ammonia ..	—	714 (17)	—	1,254 (17)	1,264 (17)
Groundnuts	2,171 (14)	540 (14)	1,392 (14)	1,265 (14)	486 (14)
Groundnuts + 100 lbs. sulphate of ammonia	2,771 (14)	812 (14)	2,200 (14)	1,331 (14)	2,074 (14)
Bush fallow	1,576 (12)	364 (10)	955 (12)	1,100 (10)	481 (10)
Bush fallow + 100 lbs. S/Ammonia ..	2,153 (10)	843 (13)	1,758 (10)	1,370 (13)	1,809 (13)
Pigeon pea fallow ..	—	364 (6)	—	1,177 (6)	437 (6)
Pigeon pea fallow + 100 lbs. S/Ammonia	—	630 (2)	—	—	1,900 (2)

N.B.—Figures in brackets are the number of plots averaged.

Except for Makanga the same trends are apparent throughout, namely a big response to nitrogen and a preceding groundnut crop.

TABLE XXVIII

Rotation Experiment No. 4 : Maize after various Crops

(*Mean Yields in lbs. grain/acre*)

Chitedze Second year

Maize after	*Nil*	75 *lbs. S/A.*	150 *lbs. S/A.*
Maize	1,666 (15)	1,917 (15)	2,347 (15)
Groundnuts	2,900 (3)	3,160 (3)	3,320 (3)
Sunnhemp	3,069 (7)	3,375 (7)	3,571 (7)
Velvet beans	3,759 (6)	3,792 (8)	3,722 (7)
Sorghum	1,829 (8)	1,966 (6)	2,558 (7)
Bush	1,506 (3)	2,352 (3)	2,129 (3)

N.B.—Figures in brackets are the numbers of plots averaged.

The beneficial effect of a groundnut crop, preceding maize, is again shown together with the value of velvet beans and sunnhemp as green manures.

TABLE XXIX

Rotation Experiment No. 2: Effect on Crops of Preceding Crops and Manures

Chitedze

Preceding crop	*Maize lbs./grain*	*Maize and beans lbs./maize grain*	*Groundnuts lbs./kernels*	*Tobacco*	
				Yield	*Grade Index*
Maize	2,872	2,288	618*	411	33.9
Maize and beans	2,915	2,295	551*	409	29.0
Groundnuts	3,118	2,795*	329	502*	31.3
Tobacco	2,818	2,361	522*	376	31.2
Mean	2,931	2,435	505	425	31.35
L.S.D.	381	442	121	83	5.8
Coeff. of variation	11.6%	16.3%	21.8%	17.5%	16.7%

Tuchila

Preceding crop	*Maize lbs./grain*	*Cotton lbs./seed cotton*	*Groundnuts lbs./kernels*	*Tobacco*	
				Yield	*Grade Index*
Maize	2,394	719*	133*	659	49.2
Cotton	2,605	603	215*	583	49.3
Groundnuts	3,280*	727*	52	718	53.8
Tobacco	3,651*	727*	209*	646	51.1
Mean	2,983	694	152	652	50.85
L.S.D.	441	60	59	77	5.4
Coeff. of variation	13.3%	7.8%	34.6%	10.6%	9.6%

**Significant increases over crop grown for 2 years running.*

Previous results are confirmed in that it does not pay to grow a crop two years running if other crops are to be grown on the farm as well. Maize is confirmed as doing best after groundnuts or tobacco. Groundnuts are best planted after maize or cotton. Cotton seems to follow well any crop but cotton. Tobacco best follows groundnuts.

Residual effects of fertilizers applied to the previous crop have been noted at Tuchila but not Chitedze. Maize has given positive responses to 100 lbs./acre superphosphate, and 75 lbs./acre sulphate of ammonia applied to a previous groundnut crop, to 75 lbs. sulphate of ammonia per acre applied to the previous cotton crop and 5 tons/acre of dung applied to a previous tobacco crop. Cotton has given a negative response to superphosphate applied to a previous groundnut crop and positive responses to nitrogen and dung applied to a previous groundnut crop. The groundnuts do not benefit from these dressings so it is better to apply the manures to the maize or cotton direct.

OX-DRAWN TOOLS

Victory Plough and Emcot Ridger

At Agricultural Research Station the Victory plough is used to do all the ploughing on the demonstration farm, about 30 acres of plough land all told. Two ox teams at most are used so ploughing continues up to the end of August. The soil is a red sandy clay loam and turns up in good clods up to the end of June after which time clods become rather large and hard to break down.

The plough has been tried for splitting ridges after harvest. It will do this but it is difficult to keep the plough straight in the ridge and a ridger or hand labour is necessary to finish the new ridges off. Splitting ridges can be reasonably carried out until mid-June at Chitedze, after which the clods cover the traces of the ridges. These clods may be broken by the use of harrows. One can make

fair ridges in a well-prepared soil using the plough but it takes time. A Velvet bean green manure crop has not been successfully turned in with the plough. Green manure has been incorporated by hand into long mounds 6–8 ft. apart, which are then ploughed out in August at the end of the ploughing season.

Costings have been kept in the past but are rather crude. A two ox team may plough $\frac{1}{4}$ acre per day during May to September at a cost of about 15s per acre. If more oxen are available, up to half an acre a day may be ploughed so cutting down the cost of manpower.

The Emcot ridger makes excellent ridges in a ploughed and harrowed field. The deeper the ploughing the better the ridge. Spacing can be varied from 2 ft. to 3 ft. 6 ins. from crest to crest. The ridger will just about re-ridge a groundnut field soon after lifting and will remake ridges on maize and tobacco land up to the beginning of May. It is well nigh impossible to split ridges with the ridger except in April, but it can be used to finish off ridges split by plough. In a good tilth it needs very little control.

It would seem that about 2 acres can be ridged per day by a two ox team for a cost of about 2s–6d per acre.

The ridger has been used to plough out groundnuts—not very well. If the wings are kept on the nuts get buried, and if the wings are taken off it is very difficult to keep the implements in the ridge at all. Ploughing the nuts out is better, but leaves a lot to the gleaners.

If a farmer is going to have one implement only, he should have the plough, but for efficiency in labour he should have a crude harrow and a ridger as well.

COFFEE

1. Cultivation and Manurial Experiments.

The layout of a shade/mulch experiment was described in last year's Report. Girth measurements can be used as an indication of growth; taken before the rains they gave the following results:

	Treatment	*Mean girth in cms.* 23.ix.54	*Mean girth in cms.* 9.ix.55.
M.	No Shade; mulched in rows	1.89 ..	2.65
SM.	Shade of *Sesbania*; mulched	1.61 ..	1.64
(1)	Shade of tall bananas; no mulch	1.56 ..	1.85
S.	Shade of *Sesbania*; no mulch	1.56 ..	1.56
	L.S.D. P=0.05	0.25 ..	0.69
	P=0.01	— ..	1.05

Note:—" Mulch " refers to a 6 in. layer of elephant grass which is cut in an area set aside for the purpose. In plot (1) the coffee is mulched only with the banana stems grown in situ.

The above figures taken one and two years respectively after planting from the nursery, reveal that those trees which were mulched and not shaded made significantly more growth than all other combinations of shade and mulch. By September, 1955, it was obvious to the casual observer that the unshaded, mulched trees in plots " M " were healthier than all others although the growing tips were markedly " bunched " and the leaves were paler than where the trees were lightly shaded. It was also apparent that least growth had been made in the *Sesbania* plots " S " and " SM " whether they were mulched or not: in these plots wilting was severe and led to leaf fall and even dieback. There is no doubt that growth in these two plots has been adversely affected by the excessive vigour of the *Sesbania* in the second year. Soil moisture measurements and a count of vacancies also help to confirm the results of the girth measurements:

	Treatment	*Number of vacancies* 9.ix.55	*Percentage moisture at depth* 0–3″	6–9″	3′
M.	.. ..	3 ..	14.1	19.0	20.5
SM.	.. ..	3 ..	14.8	13.0	16.4
(1)	.. ..	10 ..	4.9	15.0	18.0
S.	.. ..	6 ..	4.7	12.4	20.9

It may thus be concluded that mulch is essential; *Sesbania*, on account of the drain on soil moisture, especially at 6–9ins. is unsuitable at such a close spacing as 18ft × 18ft under Bvumbwe conditions; if bananas are planted at the same time as the coffee, supplementary mulch material will be necessary until the bananas have grown sufficiently.

Leaf-fall may not be entirely due to water shortage. It has been shown elsewhere that copper sprays can have a "tonic" effect. The action may be physiological or fungicidal or both. A spray made in July with Perenox (7 lbs. in 100 gallons of water) yielded no satisfactory results probably because leaf-fall was already too advanced.

Similar experiments have been set out at Cholo, where the rainfall is higher than at Bvumbwe, and at Gala, where it is lower. In both cases the treatments have been imposed on coffee that has been planted without shade a year or more previously. Thus it is too early to expect any significant results from records of girth measurements. The Cholo experiment, which has been running for a year, already shows the same sequence as at Bvumbwe; leaf-fall is occurring in plots "(1)" and "S" but is not so severe in the shaded mulched plots "SM", the apparent reasons being (i) Sesbania had not yet grown sufficiently, (ii) an overall dressing of tung cake was given to the experiment regardless of treatment.

Analysis of an NPK fertilizer trial on the sub-plots at Bvumbwe showed no significant responses at this stage.

Rainfall will eventually decide the superiority of any particular treatment in the three areas in which these experiments are situated. It should be remembered in this connection that when comparisons are made with rainfall figures of other coffee-growing countries, the total rainfall is of less importance than the distribution and in particular the amount of rain received in the dry season.

During investigations into biennial bearing in tung it became apparent that the June to August rainfall was of particular importance. It may well be that the same applies in the case of coffee. The figures below show that in each locality the 1955 rainfall was abnormally low. It was therefore not surprising that leaf-fall was greater than in the preceding year.

Locality	*Rainfall, June to August*		
	10 *year average*	1954	1955
Namingomba (Cholo)	4.16	4.21	2.80
Bvumbwe	1.94	1.93	1.14
Gala	0.35	Nil	0.22

Trials of arabica selections from Kenya and Tanganyika are being planted in the above localities next season. Planting material 15–18 months old has been found to be the most suitable; younger plants had a lower chance of survival. It was also shown that where seedbeds had not been dug deeply, twisted tap roots occurred; it is possible that such plants also have a lower chance of survival when planted in the field.

An attempt to grow lupins as a cover crop failed. They were attacked by a disease, *Sclerotium rolfsii* which was followed by termite attack. Bordeaux mixture spray failed to control and no satisfactory control is known.

2. Shelter Belt for Coffee.

Coffee is extremely susceptible to high winds, particularly when grown on the multiple stem system. Small trials of trees of possible use as a windbreak have been planted from 1945 onwards and it is now possible to advise tung and coffee growers which are the most satisfactory.

Pinus patula planted in a double row at a staggered spacing of 12 ft. has made excellent growth. Its habit is such that an effective windbreak is maintained at all levels from the base upwards. The growth of *Cupressus lusitanica* was comparable to the pines and the branch system near the ground is denser. There seems to be no advantage in too dense a screen; the root anchorage of the cypresses is weaker than the pines.

Callitris calcarata and *Grevillea robusta*, have made less satisfactory growth, the branches of the latter tending to die off as the trees gain in height. These species do not produce a strong lateral root system; thus the edge-effect of such a windbreak is not strong and the plantation crop to be protected can be planted reasonably closely. Bluegums are not a suitable subject for a windbreak unless a wide strip of unplanted land can be kept between the shelter belt and plantation.

3. Pests and Diseases of Coffee.

Study of a coffee dieback disease continues. Thanks to the services of Dr. G. B. Wallace, formerly of the Tanganyika Agricultural Department, it has now been identified as Storey's Bark Disease which is a strain of *Fusarium lateritium var. longum*. It is unfortunate that the strain present in Nyasaland is A2, the more serious of the two. It threatens to be a disease of major importance; there is as yet no certain control. Infection occurs at the base of new fast-growing shoots, particularly on stumped single-stemmed trees. Pruning back should be done in at least two stages so as to encourage slow-growing sturdy shoots rather than sappy shoots. A spraying trial has been started on one estate infected with the disease.

The main pests against which routine control measures have to be taken are *Antestia* bug, White Stem Borer *Anthores leuconotus* (in the hotter drier areas), Yellow Stem Borer *Dirphya princeps* (in the higher regions) and Leaf Miner.

Reference.

Wallace, C. B. and Maud, M.—*The Bark Diseases of Coffee.* East Afr. Agric. J., Vol. XXI, No. 1. July, 1955.

FRUIT

Fruit trials are now conducted by stations in each Province as below:

	Deciduous fruit	*Citrus*
Southern Province	Bvumbwe ..	Tuchila
Central Province	Mwera Hill ..	Chitala
Northern Province	Nchenachena ..	Nkata Bay

At each of these centres varieties that prove themselves are propagated for local distribution.

At Bvumbwe detailed records are being kept of all varieties under cultivation. Growth characteristics as indicated by measurements of trunk girth, height and spread of branches have a particular application when methods of pruning have to be considered. Thus when the two varieties of peach *Killiekrankie* and *Waldo* are considered with all other varieties on trial, the set of figures below for 18-month old trees show two widely different habits. It can be concluded that where the height about doubles the spread, heading back or some other corrective pruning will be necessary to force the branches out; a spreading habit is preferable to a fastigiate form since picking is facilitated and the lower branches remain furnished.

Peach Growth Characteristics

	Girth	*Height*	*Spread (mean of N–S and E–W.)*	*Ratio height/ spread*
Killiekrankie	1.75″ ..	9.81′ ..	4.57′ ..	2.15
Waldo Improved	1.55″ ..	8.28′ ..	6.98′ ..	1.19
Mean of all peach varieties ..	1.73″ ..	7.66′ ..	5.63′ ..	1.36

A still more important measurement is the time of leaf and flower bud burst, particularly for apples, pears and peaches with respect to the phenomenon of prolonged dormancy and for plums and almonds with respect to cross-pollination.

The problem of prolonged dormancy of buds is the most pressing of deciduous fruit growing in Nyasaland. If chilling is insufficient during the winter rest period, bud break in the Spring will be irregular and many buds may even fail and eventually die out. It has been shown elsewhere that a $7\frac{1}{2}$ per cent. spray of D.N.O.C. is effective in breaking bud dormancy; the timing is, however, critical and time of normal bud burst must first be known. The first object of trials at Bvumbwe is

therefore to select those varieties which are naturally most resistant to prolonged dormancy. Spraying to force bud break can then be used in the case of emergency or as a routine; it has already become standard practice in certain other areas of the Federation. Observations are to be made in conjunction with the Meteorological Department to determine what local conditions are most likely to bring about symptoms of prolonged rest. Light intensity is probably a factor which interacts with that of winter temperature.

Three *almond* varieties, *Britz*, *Paper Shell* and *Jordan* planted in a block, flowered profusely but only *Britz* set any quantity of fruit. Slight differences in time of bud burst may account for their failure, other conditions such as water requirements and pollination by bees being satisfactory; there may also be better pollinating varieties.

Of all deciduous fruits most interest is shown in peaches and plums. A ready market for the crop exists in Blantyre/Limbe and growing conditions are reasonable in the Shire Highlands. Previous trials have shown that it is useless to plant peaches and plums of European origin.

The most successful *peaches* are the sub-tropical (Chinese) freestones. Most of the Clingstones have been discarded as unsuitable and only *Brook* and *Kakamas* are being kept on until some other more suitable variety can be found. The freestone types, particularly those of hybrid origin, vary widely in their performance under Nyasaland conditions and, in preliminary trials at Mwera Hill, it has already been necessary to discard the varieties *Boland*, *Marina* and possibly *Elberta*. It is now obvious that the characteristic requirements for successful peach growing are:—

(i) *Early Maturing*, to avoid damage by heavy rains. Most of the clingstones have to be excluded on this count. Early maturing varieties involve the grower in the problems of irrigation.

(ii) *Resistance to Prolonged Dormancy*. Some of the new freestone hybrids, found on trial to be very resistant, have been imported. Most of the clingstones are not very resistant.

(iii) *Suitability for Canning*. There is to be anticipated a demand by a local canning factory. The clingstone type has in the past been the most suitable. It is hoped to find an early maturing variety that will be acceptable.

(iv) *Resistance to Mildew*. This disease can reach epidemic portions particularly where the trees are irrigated. Several of the sub-tropical varieties are highly resistant (*e.g. Angel*, *Waldo Improved*, *Killiekrankie* and *Shackleford*) whereas many of the clingstones are highly susceptible (*e.g. Brook*, *Kakamas* and *Yellow Clingstone*).

Plum growing poses similar problems and only the Japanese types can be grown. Varieties already proved suitable are *Santa Rosa*, *Satsuma* and *Burbank* but a further selection of varieties has been planted for trial to extend the range of quality and season. Apricots would give good crops if means can be found of preventing the maturing fruit from cracking.

A fruit-processing factory is nearing completion and its immediate demands will be for granadillas for juice extraction. About 250 acres have already been planted in Southern Province. An experiment was planted in December in order to determine,

(i) response to nitrogenous manuring,
(ii) response to phosphate,
(iii) system of training, and
(iv) need for pruning.

The first crop, a small one, was borne during the dry season (1955), there being normally a heavy crop in December/January and a smaller crop in July/August. This "fly" crop had not yet passed its peak at the time of writing but analysis of the combined yields of five recordings between 18th June and 25th August gave the results tabulated below:

Yield in lbs. fruit per acre

Experimental mean	*Sulphate of ammonia (N)*	*Training on vertical Trellis (T)*	*N x T.*	*Superphosphate*	*L.S.D. P= 0.05*	*L.S.D. P= 0.051*
400.00	+174.94	−110.58	−62.32	−8.16	55.68	76.50

The standard error of the experiment is as yet high.

Ignoring treatment (iv), which will not be introduced until the vines are at least a year old, it is apparent that sulphate of ammonia at the rate of 2/3rd. lb. per plant applied in split applications at planting time and in late February has produced a significant increase in the crop. Where the boundary or vertical type of trellis (one wire at 6ft and one below at 3ft) has been used, the crop has been less than on the telegraph system (two parallel wires running horizontally at 6ft) apparently because in the former system the vine has to be "stopped" twice in forming the framework whereas in the latter, one stopping only is usually sufficient. Even the dressing of sulphate of ammonia does not compensate adequately for this initial setback. Superphosphate at the rate of 2/3rd. lb. per plant (200 lbs. per acre) at the time of planting had no effect.

A small plot of granadillas planted a year earlier than the above experiment has shown that within the first 12 months from planting a crop in excess of one ton per acre can be expected.

The granadilla factory has also announced its interest in *guavas*. Three red varieties have now been imported with the object of propagating them as soon as they are established.

A small trial of four local selections of *Strawberries*, *Katete*, *Mwera Hill*, *Vumba*, *Salisbury*, yielded the following results in 1954:

	Yield of fruit lbs./acre 1954
Katete	2,222
Vumba	1,000
Mwera Hill	722
Salisbury	700

Yields for the first two months of 1955 have already exceeded the above figures.

The crop is grown as an annual, offsets being planted each March. The highest yielder, *Katete*, produces small to medium fruits which would be very suitable for culinary purposes. *Vumba* produces a large fruit dark in colour but is a weak grower giving rise to few offsets.

Pineapples. Spraying with alpha naphthalene acetic acid in April produced no increase in crop over unsprayed plants. By October each plot of 120 plants had produced an equal number of fruiting shoots. Further trials of pineapples should be conducted at a more suitable locality such as Tuchila.

The tips of growing shoots of apples were attacked by the adults of the bow-legged bug *Anoplocnemis curvipes* which was most troublesome in the rootstock trial beds where dieback and premature branching resulted. The young shoots of apples, quinces and figs were attacked by the elegant grasshopper, *Zonoceras elegans*. Neither of these pests is known at Mwera Hill which is situated 1,000 ft. higher than Bvumbwe.

An unidentified scale insect attacked young fig trees and stunted their growth. A mite, *Brevipalpus australis* was found disfiguring fruit and foliage of citrus in the Southern Province. It is fairly widespread and can be controlled by sulphur dust or spray.

Diseases.

Peach Leaf Curl (*Taphrina deformans*) appeared as an isolated outbreak which was controlled with a 6–6–100 strength spray of Bordeaux mixture.

Powdery mildew (*Sphaerotheca pannosa*) was again very serious at Mwera Hill and occurred for the first time at Bvumbwe. It appears that the dormant period spray of lime sulphur must not under any circumstances be missed.

Reference.

Foster, L. J.—Peach Mildew. *Nyasaland Farmer and Forester*, Vol. 2. No. 3. October, 1954.

ANNUAL REPORT OF THE TEA RESEARCH STATIONS, 1954/1955

The season under review (July 1954–June 1955) was notable for the official opening of the new laboratory and office block which was built from funds made available by the Nyasaland Tea Association. The opening ceremony was performed by Sir Malcolm Barrow, M.P., Federal Minister for Commerce and Trade, before a large audience, and it was followed by a tour of the station and field experiments.

With the planting out of the third replications of the " Complex " and " Establishment of Young Tea " experiments at Mimosa in December, 1954, the first programme sponsored by the Joint Tea Research Committee was completed. In addition, three replications of a Termite Control experiment were put in hand, and a new N.P.K. experiment was laid out on Magombe Estate in the Cholo District.

A scheme for Tea Seed Certification was worked out by the Research Committee, and it has been officially sponsored by the Nyasaland Tea Association.

The season has been one of extremes. A prolonged drought, during the four months July to October, 1954, when only 3 inches of rainfall, was followed by early and above average rains during the period November, 1954, to March, 1955. Large acreages of tea which had defoliated completely, recovered with great speed, and the season finished with record crops having been harvested on many estates.

REPORT ON FIELD EXPERIMENTS
ESTABLISHMENT OF TEA STUMPS IN THE FIELD

(i) N.P.K. Fertilizer Experiment on Young Tea, Mimosa:

Planted in December, 1953, this experiment received its first fertilizer treatments in June, 1954, and its second treatments in December, 1954. Treatments in lbs. nutrient per acre are given below:—

	First Year	*Second Year*
N0	10 lb. N as Sulphate of Ammonia	15 lb. N as Sulphate of Ammonia
N0	20 ,, N ,, ,,	30 ,, N ,, ,,
P0	0 ,, P_2O_5 as Superphosphate	0 ,, P_2O_5 as Superphosphate
$P_1$0	10 ,, P_2O_5 ,, ,,	10 ,, P_2O_5 ,, ,,
K0	0 ,, K_2O as Muriate of Potash	0 ,, K_2O as Muriate of Potash
$K_2$0	20 ,, K_2O ,, ,, ,, ,,	20 ,, K_2O ,, ,, ,, ,,

As in all fertilizer experiments on the stations, sulphur was levelled out over all treatments to eliminate the effects of " Tea Yellows ".

At the end of the first year from planting mortality counts demonstrated that treatments had not affected survival.

At first prune in March, 1955, (15 months) nitrogen has caused highly reliable increases in pruning weight. There were no other significant differences for main treatments or interactions.

(ii) Establishment Experiments, Mimosa, and the Tung Station, Cholo.

The second of three seasonal replications of this series of experiments was completed when percentage survival was recorded in December, 1954, pruning weights in March, 1955, at Mimosa, and in July, 1955, at the Tung Station, Cholo.

Treatments were reduced to four for this season's experiments, it having been decided to drop the 4 inch stump v. 8 inch stump treatment. The treatments were:—

(*a*) 18 month old stumps against 30 month old stumps.

(*b*) No nursery fertilizer against 2 oz. fertilizer (6:10:8) mixture per square yard of nursery bed.

(*c*) Stumps shaded with earthenware collar pots against shading with *Tephrosia vogelii*.

(*d*) No starter fertilizer against 1 oz. fertilizer mixture applied near the stump immediately after planting.

TABLE I

Percentage deaths of originally planted stand at 12 months

	Age (*a*)		*Nursery Fertilizer* (*b*)		*Shade* (*c*)		*Starter Fertilizer* (*d*)	
	18*m*.	30*m*.	—	+	*Pots*	*Teph*.	—	+
Mimosa ..	36.6	28.6	31.5	33.7	16.1	49.1	30.8	34.4
Tung Station ..	43.7	40.0	40.0	43.7	30.2	53.5	42.4	41.3
L.S.D.	Mimosa		P0.05 = 9.0		P0.01 = 12.8			
	Tung Station		P0.05 = 9.4		P0.01 = 12.9			

Results, in general, have followed the pattern of the first replication season 1952/1953.

The average percentage deaths over all treatments was 32.6 at Mimosa and 41.8 at the Tung Station. These are greatly in excess of normal and can be accounted for by the very bad drought during July to October, and by the fact that, as in the previous season, no selection for stump size was made in the nursery. Only 37 inches of rain fell at the Tung Station for the 12 months January to December, 1954, and of this total over 19 inches fell in the last two months. At Mimosa 32 inches out of a 12 month total of 76 inches fell in the last two months.

Only the shade treatments showed significant differences, with *Tephrosia* causing an increased mortality rate (P0.01).

Systematic relationships similar to those of the previous season's experiment were found between stump diameter and percentage deaths, and the best overall results in survival have been obtained from the following combination of treatments:—

Thirty month stumps; nursery fertilizer; starter fertilizer; and collar pot shade. The relationship between stump diameter and deaths in all plots with these treatment combinations is demonstrated in Table II below:—

TABLE II

Station	*Season*	*Stump diameters in* $\frac{1}{16}$*" and Percentage Deaths*											
		3	4	5	6	7	8	9	10	11	12	13	14
Mimosa	1952/53 ..	—	5	13	10	9	4	7	4	0	0	0	0
,, ...	1953/54 ..	33	14	7	10	3	2	0	0	0	0	0	0
Tung Station ..	1952/53 ..	50	38	21	12	10	6	9	5	0	0	0	0
,, ,, ..	1953/54 ..	100	61	46	23	16	11	15	0	0	0	0	0

Even in the very severe climate conditions at the Tung Station in 1953/54 a theoretically full stand would have been achieved by planting stumps of 10/16th of an inch diameter or over. It is of interest that on all plantings at Mimosa during the difficult conditions of last year a stand of 97 per cent. was achieved by using stumps of not less than 8/16th inches in diameter. There is no doubt that the traditional standard for stumps of "pencil thickness" is too small for Nyasaland conditions.

All plots on both stations were weighed at first prune, which took place in March 1954 (15 months) at Mimosa and in June 1954 (18 months) at the Tung Station. Results for Mimosa are shown in Table III.

TABLE III

Total weight of prunings in pounds fresh weight

Age (*a*)		*Nursery fertilizer* (*b*)		*Shade* (*c*)		*Starter fertilizer* (*d*)	
18*m*.	30*m*.	—	+	*Pots*	*Teph*.	—	+
181	163	176	168	326	18	172	172
L.S.D.	P0.05 = 69			P0.01 = 95			

The shade treatment again showed significant differences, with *Tephrosia* shade causing a marked depressing effect on growth as measured by prunings. There were no other significant differences.

In spite of the poor planting season, results from this year's experiments agree very closely with those of the previous season, and the recommendations given then have been strengthened by the latest evidence. In order to obtain the best results in both districts, as far as survival and growth up to the first prune are concerned, it is advisable to fertilize nurseries, use 4 inch stumps of diameter not less than $\frac{1}{2}$ inch, shade stumps with collar pots, and apply fertilizer either at, or shortly after planting time.

PRUNING EXPERIMENTS

(i) Length of Pruning Cycle and Type of Prune, Swazi.

Yield responses recorded below refer to the second year of the fifth successive three-year cycle.

Treatments are:—Clean prune on annual, two-yearly and three-yearly cycles; cut across prune on annual cycles, cut across prune with cleaning-out centres, and cut across on a two-yearly cycle.

TABLE IV

Yield in lbs. made tea per acre due to pruning treatments

	Clean prune			*Cut across*		
Cycle.	1-*year*	2-*year*	3-*year*	1-*year*	1-*year* (*centring*)	2-*year*
M.T.P.A.	806	840	1,035	892	890	941
L.S.D.	P0.05=138.					

The trend noted in Annual Report of 1952/53 (that in the earlier cycles of this experiment, short pruning cycles combined with cut across types of prune were better than longer cycles and clean prunes, but as the tea increased in age the reverse became true) would appear to be continuing. This season the three-yearly clean prune has significantly outyielded (Po.05) all other treatments with the exception of the two-yearly cut across, which in its turn just failed to yield significantly more than the annual clean prune.

(ii) Pruning Cycles on Local Jat Tea, Thornwood Estate, Mlanje.

One of the sets of treatments in this three-cubed factorial experiment compares the effects of one, two, and three-year pruning cycles on Local (Hybrid) Jat. Pruning type is a clean prune.

This season, the third for treatments, saw the annual plots pruned for the third successive year, the two-year plots pruned for the second time, and the three-year plots unpruned for the third successive year.

TABLE V

Yield in lbs. made tea per acre due to pruning effect, Thornwood

	Annual	*Two-year*	*Three-year*	L.S.D.	
				0.05	0.01
1954/55	1,054 ..	1,094 ..	867 ..	116	158
Mean for 3 seasons ..	1,103 ..	1,030 ..	981 ..	89	121

For the season, both annual and two-year cycles gave reliable increases in crop (Po.01) over the three-year cycle.

Over the three seasons, during which the experiment has run, the annual cycle has maintained its superiority in yield over the three-year cycle, but there is no significant difference between the annual and two-yearly cycle.

It is not possible at this early stage in the life of this experiment to draw definite conclusions, but when pruning cycle is considered in conjunction with fertilizer (see Section on Fertilizers below) there are indications that this type of local jat tea, which is traditionally given an annual prune may, with no significant loss of crop and with very distinct benefits to vigour and wood development, be worked on a longer pruning cycle.

TIPPING EXPERIMENTS

(i) Height of Tipping Experiment, Indian Jat Tea, Swazi.

Treatments are:—4 inch tip, 6 inch tip, 8 inch tip.

All plots were pruned last in May, 1953, and, during the season under review, plots were in their second year from prune.

TABLE VI

Effect of tipping height on yields of Indian tea in lbs. m.t.p.a.

(*Second season from prune*)

Tipping height	4″	6″	8″	L.S.D.
Yield	1,255	1,254	1,372	158 P0.05

No losses in crop in second year from prune have resulted from increasing the tipping height.

(ii) Tipping of Local Jat (Hybrid) Tea, Thornwood Estate.

In the Thornwood three cubed factorial experiment in which the treatments include three tipping heights of 2 inches, 4 inches, 6 inches and three pruning cycles of one, two and three years, the annual and two-yearly plots were pruned at the beginning of the season.

Results are in complete agreement with those of last year. Only during the tipping phase (July to November) does increased tipping height adversely affect crop. Over the whole season these effects are lost and no significant differences, due to tipping height, remain at the end of the season. There were again no carry over effects on unpruned plots due to tipping.

TABLE VII

Effect of tipping on yields (m.t.p.a.) on Local Jat tea, Thornwood Estate

	Tipping phase				*Whole season*			
	2″	4″	6″	*Mean*	2″	4″	6″	*Mean*
Annual cycle	82	76	59	72	1,078	1,062	1,018	1,053
Two yearly	111	76	54	80	1,186	1,045	1,045	1,092
Three yearly	46	49	49	48	827	894	876	866
Mean	80	67	54	—	1,030	1,000	980	—

L.S.D. Main Effect Tipping (0.05) = 10 — No significant differences due to tipping.

(iii) Effect of Tipping Height on Wood Formation, Thornwood.

After pruning, observations on size of new wood within the frame were again made. It is becoming more difficult to differentiate between the three tipping heights judged by thickness of new wood, due to the increasing effect of different fertilizer rates, but in general, the higher tipping levels still show increased wood formation within the bush.

PLUCKING EXPERIMENTS

(i) Plucking on 6, 10 and 14 Day Rounds, Swazi.

Now in its fifth year, this experiment has for the first time shown no significant differences in crop between the three lengths of plucking round.

TABLE VIII

Effect on yields in m.t.p.a. of increasing the length of plucking round

Length of round	6 *day*	10 *day*	14 *day*	L.S.D. P0.05
Yield m.t.p.a.	1,147	1,113	1,193	98

This tea was in its second year from prune and contrary to the suggestion made in the Annual Report 1952/53, a vigorous cropping season has not produced a bigger response to the shorter plucking rounds.

FERTILIZING OF TEA

As has been the practice in past Reports, this section will refer only to experiments planted at 4 × 4 feet spacing, and the effect of fertilizer in conjunction with different planting distances will be dealt with in the section on Spacing of Tea below.

(i) Sulphate of Ammonia at Four Rates on Mature Indian Tea, Swazi.

This experiment was started in season 1947/48 as a straight comparison between applications of sulphate of ammonia giving 0, 35, 52, and 70 lbs. of Nitrogen per acre. It has given throughout its life consistently (with the exception of N52) linear responses to nitrogen. As mentioned in last year's Report the three cubed N.P.K. experiment on Swazi now in its fourth year of treatments, has made this experiment redundant, and the opportunity has been taken to alter the treatments to N120 (in place of the former no plots), N35, N52, and N70 lbs. per acre with split plots comparing the effect of July and November applications. (*See* Time of Application of Fertilizers below.)

All plots were pruned in April, 1954, having completed a three-year pruning cycle, and the season's results are shown in Table IX below:—

TABLE IX

Effect of nitrogen (lb. m.t.p.a.) on yields of mature Indian Tea, Swazi

Lb. N per acre	120	35	52	70	L.S.D. P0.05
Yield m.t.p.a. 1954/55 ..	767	818	804	1,006	109
Yield m t.p.a. 1953/54 ..	134	247	267	337	—

The N52 Treatment has once more lived up to its unsavoury reputation. Other responses have been normal. Crops for this season are up by approximately 200 per cent. on last season and the response of the old No plots to 120 lbs. nitrogen per acre after many years of no fertilizer has been dramatic and sudden, and represents an increase of nearly 500 per cent.

(ii) Three-cubed Factorial N.P.K. on Mature Indian Tea, Swazi.

This experiment now in its fourth year of treatments, continues to demonstrate highly reliable increases in crop, due to nitrogen applications, but there are still no significant effects due to phosphate or potash. The nutrients were applied in the form of sulphate of ammonia, superphosphate, and muriate of potash.

TABLE X

Effect of N.P.K. on Yields in lbs. m.t.p.a. on Swazi

Treatment	*Nitrogen (N)*			*Phosphate (P_2O_5)*			*Potash (K_2O)*		
Nutrient level in lb. p.a.	40	80	120	0	30	60	0	30	60
Yield m.t.p.a. ..	496	714	948	726	694	736	697	731	729
L.S.D.	P0.01 = 92				None			None	

The nitrogen effect is linear up to the highest rate applied, and response to nitrogen repeated last season's figures of 5.4 lbs. made tea per lb. nitrogen between the two lower rates, and 5.7 lbs. made tea per lb. of nitrogen between the two higher rates.

(iii) Sulphate of Ammonia on Local (Hybrid) Jat Tea, Thornwood Estate.

This three-cubed factorial experiment combines three pruning cycles, three tipping heights (both already referred to above) and three levels of nitrogen. The nitrogen rates are 40, 80, and 120 lbs. per acre supplied in the form of sulphate of ammonia. The season's results, together with the mean for three seasons (end of the first three-year pruning cycle) are summarized below:—

TABLE XI

Effect of sulphate of ammonia in lbs. m.t.p.a. on Local Tea, Thornwood

Nitrogen lbs. per acre	40	80	120	L.S.D. P0.01
Yield 1954/55	800	1,004	1,210	158
Mean three seasons	859	1,034	1,222	121

Highly reliable increases in crop are again demonstrated for each upward step in nitrogen, with no falling off in effect even up to the highest rate. Response in lbs. made tea at 5.1 for each lb. of nitrogen for this season show a slight increase over last year. Over the three seasons response per lb. of nitrogen stands at approximately 4.5 lbs. made tea.

The increased response to nitrogen by unpruned tea is again apparent from Table XII.

TABLE XII

Response in lbs. made tea to each lb. Nitrogen

Nitrogen	*From* 40 *to* 80	*From* 80 *to* 120	*Mean*
Pruned Tea	3.69 ..	4.92 ..	4.31
Unpruned Tea	7.85 ..	5.51 ..	6.68

(iv) Sulphate of Ammonia at Four Rates on Young Indian Tea, Swazi.

The tea in this experiment is now nine years old. The four nitrogen rates supplied as sulphate of ammonia are 0, 80, 160 and 240 lbs. per acre. Yields for the season are as follows:—

TABLE XIII

Effect of Nitrogen on yields in lbs. m.t.p.a. on young Indian Tea

Nitrogen level in lbs.	*0*	*80*	*160*	*240*	L.S.D. P0.05
Yield lb. m.t.p.a.	1,249 ..	1,444 ..	1,447 ..	1,439 ..	143

All three fertilizer rates have given significant increases in crop over the no nitrogen control, but as in previous years there are no significant differences in yields between any of the nitrogen treatments. The conclusion reached last year that young tea cannot utilize efficiently more than 80 lbs. nitrogen per acre is further strengthened. Response in made tea per lb. of nitrogen added between No and N80, was 2.44 lbs.

(v) Nitrogen or Sulphur Experiment.

There are still no significant differences in yields between nitrogenous fertilizers with and without sulphur.

TIME OF FERTILIZER APPLICATION

(i) Four Times during the Main Cropping Season, Swazi.

Eighty lbs. of nitrogen as sulphate of ammonia per acre per season are applied at the following four times:—

N Whole application first week November.

$\frac{1}{2}$N$\frac{1}{2}$J Half application first week in November and half first week in January.

J Whole application first week January.

$\frac{1}{2}$N$\frac{1}{2}$M Half application first week November and half first week in March.

As for previous seasons there were no formal significant differences due to treatments. Yields for the past five seasons, as recorded below, still suggest that more crop results from a whole November application.

TABLE XIV

Yields from four times of fertilizer application expressed as percentages of the whole November treatment

Time of Application	*Mean over 5 seasons*
N	100%
$\frac{1}{2}$N$\frac{1}{2}$J	94.9
J	92.8
$\frac{1}{2}$N$\frac{1}{2}$M	89.6

(ii) Dry Season Application against Early Crop Season Dressing, Swazi.

The experiment referred to above (Fertilizing Tea (I)) has split plots comparing a complete July application at the beginning of the dry season, with a complete November application at the beginning of the main rains and cropping season.

Sub-treatments have now completed three seasons, and continue to show reliable gains in crop from the November application.

TABLE XV

Effect of July and November fertilizer applications on tea yields expressed as a percentage of the November yield

	Time of Application		L.S.D.	
Season	*July*	*November*	P0.05	P0.01
1952/53	86.7%	100%	.. —	9.6%
1953/54	85.5%	100%	.. —	9.3%
1954/55	92.9%	100%	.. 6.2%	—

(iii) Three Times of Application, Swazi.

As from September 1954 the 4 inch, 6 inch, 8 inch, Tipping Experiment (*see* Tipping Experiments. (I)) on Swazi has had its fertilizer dressing of N80; P25; K20 applied at three different times as complete applications. The times of application are September in the middle of the dry season, November at the start of the main rains and cropping season, and January in the middle of the main cropping season.

This, the first year of these sub-treatments, has shown no significant differences in the season's crop due to the different times of fertilizer application. These three experiments now cover practically the whole season, and although no conclusive results have been obtained, present evidence points to the early November or October dressings as being the most reliable for crop production.

SPACING OF TEA

(i) Spacing and Sulphate of Ammonia, Mimosa.

Two replications of this four-squared factorial experiment were planted in December, 1951, and the third replication one year later. The treatments are:—

Spacings		*Nitrogen rates*
4′×4′ square	(2,720 bushes p.a.)	40 lbs. per acre
4′×3′ ,,	(3,630 ,, ,,)	80 ,, ,, ,,
5′×(2½′×2½′) hedge	(4,600 ,, ,,)	160 ,, ,, ,,
4′×(2′×2′) hedge	(7,260 ,, ,,)	240 ,, ,, ,,

Full nitrogen rates were applied in November, 1954, to Replicates I and II and N30, 60, 120 and 180 to Replicate III. For the reasons outlined in last year's Report, sulphur was levelled out over all plots.

Replicates I and II received their third prune and Replicate III its second prune in early May, 1955, and yields referred to below cover the period July, 1954, to early May, 1955.

(*a*) Effect of Nitrogen on Yields made Tea per Acre.

Yields are summarized in Table XVI below and although there were no significant differences due to nitrogen rates, there are indications that for tea of this age 40 lbs. of nitrogen is too little, and 240 lbs. is wasteful.

TABLE XVI

Nitrogen lbs. p.a.	40	80	160	240	L.S.D.
Yield lbs. m.t.p.a. ..	250 ..	270 ..	283 ..	274 ..	None

(*b*) Effect of Spacings on Yields Made Tea per Acre.

Increasing the stand per acre has given reliable increases in the yield of made tea per acre.

TABLE XVII

Spacing	4′×4′	4′×3′	5′×(2½′×2½′)	4′×(2′×2′)	L.S.D. P0.05	L.S.D. P0.01
Bushes per acre	2,720	3,630	4,600	7,260		
Yield lbs. m.t.p.a.	231	272	309	265	30	41

All spacings have yielded significantly more crop than the 4 ft. × 4 ft. square planting, with the 5 ft. (2½ ft. × 2½ ft.) hedge planting significantly the highest yielder although it is not the highest stand per acre. There was no difference between 4 ft. × 3 ft. and 4 ft. × (2 ft. × 2 ft.), spacings.

(*c*) Effect of Nitrogen on Pruning Weights.

Averaged over all four spacings nitrogen had no significant effects either on weight of prunings per acre or on mean pruning weight per bush.

(*d*) Effect of Spacings on Pruning Weights.

Yield of prunings in lbs. per acre, and mean bush weight of prunings are summarized in Table XVIII below:—

TABLE XVIII

Spacing	4′×4′	4′×3′	5′×(2½′×2½′)	4′×(2′×2′)	L.S.D. P0.05
Weight of prunings (3rd prune) in lbs. per acre	4,794	5,233	5,715	5,154	602
Mean bush weight	1.8	1.4	1.2	0.7	0.3

As was the case last season (second prune), this season increased stand has caused increased weight of prunings per acre for the third prune. The increase is no longer systematic, however, the three highest stands per acre having levelled out. Only the 5 ft. × (2½ ft. × 2½ ft.) hedge planting has yielded significantly more prunings per acre than any other spacing, and then only better than the lowest stand of 4 ft. × 4 ft.

Mean bush pruning weight has also shown a change from the previous season. The 4 ft. × 4 ft. spacing mean bush pruning wieght is significantly greater than all other spacings. The 4 ft. × 3 ft. and 5 ft. × (2 ft. × 2 ft.) spacings are not significantly different but both have significantly heavier mean bush pruning weights than 4 ft. × (2½ ft. × 2½ ft.).

There are no significant interactions Nitrogen × Spacings either for made tea or pruning weights.

(ii) Spacings and Sulphate of Ammonia ("Complex" Experiment), Mimosa.

The two other experiments including different spacings and different rates of nitrogen on Mimosa are the first two replications of a three to the fourth factorial combining spacings, nitrogen rates, length of pruning cycle, and type of prune all, at three levels.

The first replication was planted in December, 1952, and the second in December, 1953. So far only the spacings and nitrogen treatments have been applied, and these treatments are:—

Spacings		*Nitrogen*
4′×4′ square	(2,720 bushes p.a.)	40 lbs. p.a.
4′×3′ ,,	(3,630 ,, ,,)	80 ,, ,,
4′×(2′×2′) hedge	(7,260 ,, ,,)	120 ,, ,,

The nitrogen rates are applied in yearly increasing applications until the full rate is reached in the fourth or fifth year from planting. The rate for this season when the tea was entering its third year was N30, 60, and 90 lbs. per acre as sulphate of ammonia, and following previous experience, sulphur was levelled out to that of the highest sulphate of ammonia level in order to eliminate "Tea Yellows".

(*a*) Effect of Nitrogen on Yields of Made Tea per Acre.

Increased rates of nitrogen just failed to show significance at P0.05, which is in line with past experience at Swazi and in other countries. Young tea does not respond to high nitrogen dressings.

(*b*) Effect of Spacings on Yields of Made Tea per Acre.

Results followed very closely those obtained in the Spacings × Nitrogen Experiment (Spacing of Tea (1) above) when it was of the same age last season.

TABLE XIX

Spacing	4′×4′	4′×3′	4′×(2′×2′)	L.S.D. P0.01
Yield in lbs. m.t.p.a.	108 ..	124 ..	158 ..	13

In the third year from planting highly reliable increases in crop resulted from increasing the stand per acre.

(*c*) Effect of Nitrogen on Pruning Weight per Acre and Mean Bush Pruning Weight.

No significant effects in either resulted from different rates of application of nitrogen for first or second prune.

(*d*) Effect of Spacings on Pruning Weight per Acre and Mean Bush Pruning Weight.

TABLE XX

Spacing	4′×4′	4′×3′	4′×(2′×2′)	L.S.D. (P0.01)
Pruning weight p.a. 2nd prune ..	3,056 ..	3,361 ..	4,019 ..	511
Mean bush pruning weight 2nd prune	1.08 ..	0.92 ..	0.55 ..	0.12

As for last season increased stand resulted in increased pruning weight per acre, with the reverse being true for mean bush weight of prunings. The second replication of this experiment was pruned for the first time in April, 1955, and followed the same pattern.

In the two experiments reported upon in this Section, information on the effect of spacing now covers the first prune (15 months from planting) second prune (28 months from planting) and the third prune (40 months from planting). So far, the pattern is fairly definite. During the first three seasons the closest spacings produce both more crop and more prunings per acre. In the fourth season the 4 ft. × 2 ft. × 2 ft. spacing has been surpassed by both the 5 ft. × 2½ ft. × 2½ ft. and the 4 ft. × 3 ft. but still maintains its superiority over the 4 ft. × 4 ft.

PERMANENT SHADING OF MATURE TEA

(i) Observation Plots, Swazi.

For the sixth successive year yields were recorded from observation plots in which half are shaded by *Albizzia glabrescens* and half unshaded. One half of each plot receives 80 nitrogen per acre as sulphate of ammonia, and one half is not fertilized. The season's results are recorded below.

TABLE XXI

Effect of shade, with and without nitrogen on yields in lb. m.t.p.a.

	Without Shade	With Shade	Mean for Nitrogen
Without Nitrogen	279 ..	541 ..	410
With Nitrogen	651 ..	680 ..	666
Mean for Shade	465 ..	610 ..	—

Shade has once more increased yield substantially. Nitrogen has also increased yields but again the response under shade is less than without shade. Responses in made tea for each lb. of nitrogen added were 4.7 lbs. without shade and 1.7 lbs. with shade.

(*ii*) Shade Trees and Fertilizers, Mimosa.

This experiment compares four types of shade combined with four rates of fertilizer. The tea is in its fourth year from planting, and the shade trees are two and a half years old. No differential fertilizers have yet been applied. The shade treatments are:—No shade, *Albizzia gummifera*, *Gliricidia maculata*, and *Grevillea robusta*.

Yields of made tea per acre are detailed in Table XXII below.

TABLE XXII

Effect of shade trees on yields in lb. m.t.p.a., Mimosa

Shade	*No Shade*	*Grevillea*	*Gliricidia*	*Albizzia*	L.S.D.
Yield ..	.. 215 ..	235 ..	198 ..	233 ..	None

There are no significant differences in yield of tea due to shade, and this is true also for pruning weights at the third prune. Of the three types of shade, *Gliricidia* is the only one, as yet, which has made sufficient growth to produce anything approaching an effective shade and it is curious that it has been outyielded by the others.

Pests and Diseases

(i) Diseases:

The country's fortunate position as far as diseases are concerned has been maintained, and apart from the ever-present *Armillaria mellea*, which is still responsible for many losses, and the two "Violet Root" Diseases *Helicobasidium compactum*, and *Sphaerostilbe repens*, only minor diseases have been reported. Of these, *Sclerotium rolfsii*, which has reappeared in a nursery after some years, and a species of *Septobasidium* (Velvet Blight) are the most unusual.

(ii) Pests:

The four major pests *Helopeltis bergrothi* (Mosquito Bug), *Metatetranychus bioculatus* (Red Spider), *Physothrips setiventris* (Thrips), and the ubiquitous termite have been much in evidence during the season. Growing concern is evident at the increasing damage to young tea stumps caused by termites, and this season three complete replications of a termite control experiment were put down in the Mlanje District.

Of a randomized block design, this experiment compared the efficiency of several of the newer chemicals as termiticides. The treatments were:—

(1) *DIP*—Using "*DIELDREX 15*" emulsion at a dilution of 1:11, the aerial portion of the stump prepared for planting was dipped for ten minutes, removed and allowed to dry, then planted out.

(2) *Soil Dressing Dry*—"*DIELDRIN*" 50 per cent. wettable powder was applied round the soil at the base of the stump shortly after planting out, at 3 lbs. active ingredient per acre. Fine sand was used as a filler. One-third of the normal round cigarette tin of the mixture per stump was the measure used.

(3) *Soil Dressing Wet*—"*DIELDRIN*" 50 per cent. wettable powder applied to soil round base of stump shortly after planting, as a solution at 3 lbs. active ingredient per acre, and one-fifth of a pint per stump.

(4) *Soil Dressing Wet*—"*Peschlor*" (Chlordane emulsion concentrate) applied to soil round base of stump as an emulsion diluted 1:1,000, and at one-fifth of a pint per stump.

(5) *Soil Dressing Dry*—"*CHLORDANE*" 5 per cent. powder applied as for treatment number 2.

Treatments were applied in January, 1955, approximately three weeks after planting, and termite damage was recorded after three months and after six months.

TABLE XXIII

Percentage Termite Attack over Three Sites

Treatment	1	2	3	4	5	(*Control*) 6	L.S.D. P0.01
At 3 Months	0.86	1.17	2.10	1.66	1.33	3.63	1.50
At 6 Months	1.80	2.43	2.79	2.78	2.97	7.99	1.89

All treatments are significantly better than the control, but there are no significant differences between any of the chemical treatments.

The percentage attack has been lower than normal, possibly due to the high rainfall at the beginning of the season. It has been noted that these termites become much more active in their attacks on tea stumps when soil moisture is low, and in order to obtain more information on the residual effect of these chemicals, especially in the dry season, it was intended to split the plots and retreat half of each. Shortage of staff has prevented this being done to date.

On the evidence obtained it would appear that any of the treatments used will give effective protection to young tea stumps for at least six months. Until more information is available, it would be advisable to give a second application when soil moisture becomes low, say in September.

Although no treatment is significantly better than any other, the "Dip" treatment with *Dieldrex* 15 has given greater protection and is attractive also because the treatment can easily be given at the nursery site, when stumps are being lifted and prepared for planting, thereby affecting a considerable saving in labour.

EXTRACT FROM AGRICULTURAL CHEMIST'S REPORT

Work in connection with tea has chiefly consisted in soil surveys of new areas for development and in analyses of estate samples, all of which have contributed to the general assessment of the nutrient status of the soils of the area.

In the examination of development areas, the division of soils according to geological origin—was again apparent, *e.g.* biotitic gneisses gave rise to compacted clay soils—syenite and syenitic gneisses to rather compacted soils of more sandy texture, while the best soils were those derived from dolerite, or those which had accumulated in localized pockets. Generally, the extent of these better soils was sufficient to make recommendations for opening areas of practical size.

From the data now accumulated, a nutirent status map is being prepared for the Zomba/Blantyre/Mlanje area. The main point to emerge is the necessity of maintaining organic matter to conserve applied fertilizers and also to mobilize phosphates. The possible depletion of potassium, referred to in last year's Report, has been further investigated, and the following results may be quoted. The data refer to the present potassium contents m.e.p.c.

Date of Planting

Estate	*Before 1920*	*1920–30*	*1930–40*	*1940–50*
A.	0.09–0.3 ..	— ..	0.24 ..	0.5–0.7
B.	— ..	0.19 ..	0.24 ..	0.5–0.8*
C.	— ..	0.3–0.5 ..	— ..	0.6–0.8
D.	— ..	— ..	0.4 ..	0.5–1.1†
E.	0.2–0.3 ..	0.3–0.6 ..	— ..	0.6–0.9
*One field	0.2 ..	†mean of 15 fields		0.65

However, soil analysis may not tell the whole story as much depends on the mobilization of potassium supplies. It may, however, be noted that in Ceylon, potassium deficiencies occurred when the leaves contained only 0.5 per cent. K_2O, but all Nyasaland leaf so far examined has

contained 1.2 per cent. to 2.1 per cent. K_2O, fertilizer experiments are, however, planned on soils of low potash content, so that any depletion will be immediately apparent. Most of the soils would be classed as marginal to satisfactory as regards available phosphate supplies—but it should be noted that these vary appreciably in localized areas. For example, at Mimosa tea station on two replications of an N.P.K. experiment, separated by only 200 yards, the available phosphate contents were 23 and 140 with reserve supplies at 61 and 120 respectively. Such evidence emphasizes the need to assess fertilizer requirements on smaller units than just "the estate". The effect of continued application of sulphate of ammonia on the soil was seen from the long established experiment at Swazi. The reduction of pH being seen in the following results, which are the mean of eight different samples from each treatment, *viz*:—0, 21, and 63 lbs. N for five years, with 0, 35 and 70 lbs. of N in the five subsequent years to the present time.

Nitrogen level ..	.. *0*	.. *35*	.. *70*
pH ..	.. 5.0	.. 4.75	.. 4.6
N% ..	.. 0.11	.. 0.13	.. 0.13

It was interesting to note that the greater dressings of ammonium sulphate had not reduced the potash supplies as far as could be seen from soil analysis. Similarly, the occurrence of fungal attack on tea bushes on one estate where ammonium sulphate had been applied at 500 lbs./acre, raised the query as to whether this was being increased by a changed C/N ratio. Analyses of leaf and soils from this estate indicated that no hazardous depletion of potash was being caused by the sulphate of ammonia. These initial results were, however, obtained in the dry season, and it will be necessary to repeat the leaf analysis, at full flush—so that leaf composition may be studied at the period of maximum growth.

AGRICULTURAL CHEMISTRY

(Report of Agricultural Chemist, Bvumbwe)

A. Soils and Nutrient Studies

1. Chilwa Rice Scheme.

(*a*) *Soil Survey.*

The whole of this 20,000 acres area was examined on a 500 yard grid, inspection pits to 3ft. depth being dug at each point. With adequate labour, this method seemed more efficient than the surveyor using an auger, as many pits could be prepared for subsequent examination together. Over 700 samples were examined in the laboratory, chiefly for pH and salinity determinations, full analyses being made on samples from 44 representative profiles.

The Soil Series.

The soils have been classified as follows:—

Series I. Extent 4,000 acres. A dark grey slightly acid (pH 5–6) medium clay of low salinity (0.03 per cent. soluble salts) overlies soil of increasing clay content with depth. The pH changes to 6.5 at 12 ins., until at 3 ft., the soil is neutral. At 4 ft.–6 ft. a few lime concentrations are found. The general level of salinity at 3 ft. is 0.1 per cent. soluble salts. Potassium supplies decrease through the profile (from 2.0 to 0.6 m.g.e.). Calcium and magnesium increase from 18–40 to 30–45. The sodium figures follow the salinities the general level in the top soils being 1-2 increasing to 5–8 at 3 ft., with occasional concentrations of 10. Available phosphate appears satisfactory in the range 30–40 p.p.m. The nitrogen and organic matter content is only medium and there is a sharp decrease in the 3–12 ins. horizon, to only about one-quarter of the value in the top 3 ins.

Series II. Extent 3,500 acres. May be considered as a continuation of Series I, the main change being that the alkalinity is rather higher throughout the profile—the pH being 8.5 at 3 ft., whereas in Series I the soil at 3 ft. is generally neutral. The top soil and immediate sub-soil are slightly acid. The nutrient levels and ranges are similar to those of Series I, except that the rather more alkaline heavier clays are found at 3 ft. in Series II. There is a corresponsing increase in calcium and magnesium content, until near the Lake in the lower horizons, calcareous concretions are

apparent, $CaCO_3$ varying from 0.2 per cent. to 8.0 per cent. The salinities of the top soils are about the same as in Series I, the lower horizons generally being of greater salinity (to 0.2 per cent. chloride) although the values are lower in those pits nearer the river and Lake. The sodium concentrations follow the salinities, the range being up to 2.5 in top soil and from 7 to 16 at 3 ft. Available phosphate supplies again appear satisfactory. In the area of this series there are occasional irregularities caused by the presence of such hills as Nkholonje wa madzi, and the intrusion of the edge of Series IV.

Series III. (Extent 3,000 acres surveyed, but larger area to the North). The soils in the area are much heavier and are generally calcareous throughout the profile—up to 12 per cent. $CaCO_3$ being found in some pits in the 3 ft. horizon, the surface concentration being up to 6 per cent. The salinity is higher than in Series I and II in the top soils, due to Lake flooding, but in the lower horizons the proportionate increase is not so great, and salinity decreases as the Lake is approached. This is most probably due to the fact that these soils are permanently wet and little concentration due to evaporation occurs in the sub-soils. The increase in salinity is due to salts other than chlorides, sodium carbonate being present.

Potassium supplies seem satisfactory, and the calcium and magnesium levels are high. In fact there is a possibility that these calcareous soils would induce deficiencies of some essential elements *e.g.* iron. The sodium content is much higher throughout the whole profile in this series—reaching a maximum of 11 in the top soil and 33 at 3 ft. Phosphate supplies appear satisfactory. The organic matter of the top soils is much higher than found elsewhere—rising to 10 per cent. in some places, with corresponding increase of nitrogen to 0.3 per cent. There is, however, the same sharp decrease in the lower horizon, *e.g.* the top 3 ins. contains 12 per cent. organic matter, but the 3–12 ins. horizon only has 3.5 per cent. The higher C/N ratio in these areas confirms that this organic matter is due to accumulation of decomposing reeds.

The surface of this soil cracks into complex patterns and is characterized by " gilgai " formations—due to the oblique movement of the underlying heavy clays. Photographs and diagrams of the cracking patterns were prepared.

Series IV. This smaller area of 1,500 acres contains soils of highest salinity and alkalinity—this being due to its higher elevation, and consequent greater concentration by evaporation. The area is rocky, and generally the soils are more sandy throughout the profile, the soils containing from 4 to 8 per cent. stones. This does not, however, affect their general impermeability for rice, although the rocky outcrops, and surface stones would make their use rather difficult.

Series V. Occupies 200 acres, to the East of the area. This consists of a neutral top soil overlying soils becoming alkaline at depth. A few limestone concentrations occur at 3 ft., but not to the same extent as found in Series III, and in this respect this Series resembles I and II. The higher salinity of the lower horizons is similar to that of Series IV, as would be expected from the position of the flood line.

Series VI.—(Brown)—This area of approximately 1,200 acres marks the Southerly limit of the *dambo* proper. The top soils are similar to those of Series I and II, but are rather more stony. The lower horizons, however, contain a higher proportion of soluble salts, in which chlorides generally predominate as opposed to the high proportion of soluble carbonates found in the soils of similar total salinity, in Series III. The reaction changes from slightly acid in the top soil to neutral, with a few calcareous concentrations at 3 ft. The potash and phosphate supplies seem adequate but the nitrogen is only medium.

(*b*) *General Description of the Area.*

The soils of the Chilwa Rice Project are composed of medium and heavy clays, which have accumulated in the valleys of the area, the " peaks ", of which remain to be represented by hills such as Nkholonje wa madzi, and the rocky outcrops found in Series IV.

Their reaction and salinity appears to be governed by distance from the Lake and the general topography. Where flooding appears to be chiefly from Lake Chilwa, the soils are calcareous, alkaline, and more saline as found in Series III.

Flooding from the Sombani River or direct accumulation of fresh rain water by run off from the higher hinterland appears to occur on Series I and II and hence the soils here are slightly acid in

their upper horizons, becoming neutral or slightly alkaline at depth. The increase in salinity with depth is more marked in the higher sections, where longer dry periods allow greater evaporation and hence more concentrations of salts. In the higher areas the salts are chifly chlorides, but in the lower calcareous sections near the Lake, the presence of sodium carbonate appears marked.

No sharp demarcation can be made as even in Series II the soils are more alakaline at depth as Series III and the Lake are approached.

No topographical map is available but, an earlier survey had shown a fall of 15 ft. from the pilot plot towards the North-East, to a point approximately near the Northern limit of the soil survey. The vegetation of the area follows closely the flood line for the division between *Acacia seyal-Setaria* sp. group and the *Hyparrhenia* sp.—*Vossia* group. In the permanently wet sections, dense stands of reeds and bullrushes are found. The higher section, *e.g.* Series IV, is characterized by *Sesbania* sp. A preliminary examination of the areas West of the Sombani has indicated that the soils here are essentially of the Series I type.

In none of the soils of Series I and II is salinity high enough to affect rice growth if fresh water irrigation is carried out. In the higher sections of Series II, and in this area as Series III is approached the exchangeable sodium is higher reaching 6 m.g.e. in the first foot of soil. Free chlorides are, however, slow, and irrigation should prevent any increase from the lower horizons, which are richer in chlorides.

A concentration of 0.35 per cent. sodium chloride is reported as preventing satisfactory root development in rice, but any such limits must also depend on the variety. Also, although satisfactory growth may be obtained, salinity does reduce grain development, and this aspect will have to be watched in the experiments with Chilwa water.

The area is characterized by shallow top soils—and it appears that the main need will be for nitrogenous fertilizers. The supplies of available potash and phosphate appear satisfactory although again these fall away rather sharply below the 3 ins., level. Disturbances of the soils, must, therefore, be reduced to a minimum if even growth of rice is to be obtained.

The underlying sandy horizon, found on the 100 acres plot, did not occur outside this area, but it was interesting to see that this sand strip was very noticeable because of the restricted growth of rice on this soil. This was due to excess seepage of water and although the survey did reveal uniform clay, the behaviour of the rice on the sandy strip emphasizes, the need for adequate surveys to be made.

The soils are satisfactorily supplied with potash and available phosphate, but the shallow top soils mean that more nitrogen will be required.

The composition of representative samples of the series is shown below.

TABLE I

Depth In.	Texture				*		%					*P (p.p.m.)*			
	pH	% *sand*	% *silt*	% *clay*	% *TSS*	*B.E.C me %*	*Base Sat.*	*K me %*	*Na me %*	*Ca me%*	*Mg me%*	*avail.*	*reserves*	% *C*	% *N*
0–3″	6.0	30	16	49	.04	27.5	90	0.65	2.22	16.6	10.6	26	40	0.8	.05
3–12″	6.2	27	16	54	.04	26.4	91	0.21	1.32	20.6	14.4	22	24	0.8	.04
36″	7.5	22	16	58	.16	—	—	0.51	12.2	24.6	15.0	—	—	—	—
60″	7.0	23	17	58	.28	—	—	0.33	10.5	25.4	25.8	—	—	—	—
	Series IV														
0–3″	7.1	74	20	11	.02	20.6	100	0.88	1.4	8.6	6.8	53	155	2.2	.15
12″	7.2	73	12	17	.06	17.2	100	0.35	2.8	5.8	8.4	—	—	—	—
36″	7.7	45	14	41	.42	42.4	100	0.68	16.5	22.2	16.0	—	—	—	—
	Series III														
0–3″	7.0	41	12	43	.05	42.4	100	2.20	6.2	36.0	14.0	26	†106	6.1	.30
12″	8.8	18	14	62	.10	47.2	100	2.30	15.0	84.0	21.0	26	97	1.9	.08
36″	9.0	8	11	72	.29	52.1	100	1.75	8.5	99.0	17.0	31	123	0.2	.01

*TSS = Total soluble salts.

† = Phosphate by saturated CO_2 solution extract is 3 p.p.m.

(*b*) *The use of Lake Chilwa water for irrigation*

As it became clear that the Sombani River would not provide all the water necessary for 10,000 acres of rice, the possibility of using water from Lake Chilwa was investigated. This was known to be saline, and so bimonthly samples were taken to assess seasonal changes. The results of these, together with other data regarding the Lake, are summarized below for the main body of the Lake.

TABLE II

	August	*October*	*November*	*January*	*March*	*June*
pH	8.5	8.8	8.6	8.2	8.3	8.9
Total salts. p.p 100,000	140	180	165	105	37	64
Sodium ,,	83	70	65	55	29	36
Chloride ,,	45	53	63	37	12	28
Carbonate ,,	15	12	26	19	3	9
Bicarbonate ,.	72	87	70	62	20	29
Residual S. Carbonate	17	—	—	15	2.5	—
Sodium Absorption Ratio	35	—	—	17	9	—
Equil. %Sod. in Soil	36	—	—	19	11	—
Rainfall	0.1	0.7	4.9	10.2	—	—
5 yearly mean	0.1	1.3	2.5	12.5	7.6	0.1
Gauge Height at Ngalangala	2.7	1.6	1.0	3.9	—	—
Depth of Lake	5′	4′	3′	3′	6′–9′	7′–9′
Evaporation	5.7	8.1	8.3	5.6	6.1	5.0

The potassium, calcium and magnesium content did not vary appreciably, being 1 to 3, 1 to 1.7 and 0.5 to 1.2, respectively.

Samples were also taken from various locations and depths, particularly to test whether there was any appreciable quantity of fresher water, accumulated where the rivers flowed into the Lake. No variations with depth or with distance from the shore were found, although occasional small pockets of fresh water were found in the reeds.

On the basis of this data, the use of Chilwa water appeared problematical, but tests were made to investigate its effect on the soil of the area. In December, 1954, soils representative of the higher (Series I) and heavy (Series III), were soaked with Chilwa water for one month. They were then filtered, washed free of soluble salts, and the final soil examined for exchangeable cations. The filtered Chilwa water was also examined for change in composition.

TABLE III

Composition of Lake Chilwa Water

	Cl	*Ca*	*Mg*	*Na*	*K*
Original Water	53	1.1	1.2	68	2.1
Content after soaking with lighter soil	58	1.9	1.2	35	2.0
Content after soaking with heavy soil	60	2.8	5.3	47	1.7

Analysis of the soils gave the exchangeable sodium as 3.8 m.g.e., per 100 gm and 10.5 m.g.e. in the lighter and heavy soils respectively. The corresponding figures for potassium were 1.2 m.g.e. and 2.1 m.g.e. The change in composition of the water, represents an absorption of 4.0 m.g.e. Na on the lighter soil, and 2.6 m.g.e. on the Series III soil. These initial figures do indicate that under equilibrium conditions, the exchangeable sodium would comprise about 15 per cent. of the total bases present, the sodium originally present being 3 per cent. of the total bases.

In conjunction with these determinations, trial irrigation plots were laid down at Sombani in December. At the end of May—soil samples were taken from the four small plots which had been

irrigated with (*a*) Chilwa water; (*b*) 50 per cent. Chilwa water; (*c*) Chilwa water in January and April; and (*d*) Sombani water, since December, 1954. In February, analysis of water lying on the plots was made and this indicated that appreciable dilution had been caused by rain—so that in effect the plots were subject to water of only about 1/10 the strength of Chilwa water.

For the Series I type soil, there was very little difference in the amount of adsorbed sodium in the soils with the three different treatments, although the total and exchangeable sodium is slightly higher where Chilwa water only has been applied all the time. The rather uniform nature of all the plots suggests that there has been a certain amount of lateral movement of the solutions, and for any further trials improved isolation of the plots would have to be considered.

Fifty per cent. Chilwa water produces only slightly less effect and the results with Sombani water—again suggest lateral movement of solution between the plots. The adjoining soil subject to rain water only contains less sodium than found in the others. The Na percentage in the base-complex is about 6 per cent. in all the soils treated with Chilwa water, 3 per cent. in that on which river water only was used, and 2 per cent. on the non-irrigated soil. These figures compare with the 15 per cent. found in the laboratory test with Chilwa water at full strength. It should be noted that the total amount of water applied in these tests was acre feet of Chilwa water.

This figure of 6 per cent. agrees reasonably with the theoretical figure of 5–6 per cent., calculated from the S.A.R. of the water at the strength at which it was lying on the plots in February. Permeability difficulties would become appreciable after the exchangeable sodium comprises 15 per cent. of the base-complex, and toxicity at 40–50 per cent.

This preliminary trial sorted some of the definitely unsuitable varieties—and a larger scale experiment is now planned, so that any reduction of yield in the salt tolerant varieties, may be estimated. Chilwa water is also being applied to the small plots throughout the dry season, so that the effects of continual irrigation may be accelerated to enable some assessment of the ultimate state of the soil to be made.

(2) Reclamation of the Elephant Marsh—(Chiromo–Chikwawa).

One development of the Shire Valley Project would be the drainage of the area between Chikwawa and Chiromo, known as the Elephant Marsh, an area which was successfully cultivated before flooding occurred in 1935. Following a brief examination of the edge of the area by Drs. Greene and Muir in September, 1954, 205 soil samples were taken by the surveyors from 50 profiles and these were examined in the laboratory.

The reclamation of the Elephant Marsh area, would not be in the same category as usually represented by the word " reclamation ". No salt water flooding has been involved as occurs in coastal areas, and neither has the area been subject to long-standing stagnant water as usually occurs in marsh lands. Under these conditions, the decomposing organic matter forms high concentrations of sulphides, which on drainage of the land, oxidize to sulphates which may then occur in sufficient amounts to cause salinity problems. The Elephant Marsh has generally been subject to moving water, and thus no such formation has occurred. This is seen in the low content of sulphates found in those soil samples tested. From a reclamation viewpoint then, this area may almost be considered to have only been under irrigation conditions for the past 20 years, and no detrimental effect appears to have occurred by flooding with fresh water from the Shire. The soils have undoubtedly benefited by this flooding as alluvium has been deposited over them. These heavier clay soils may, however, cause difficulty in working the reclaimed land. A further effect to be watched during the drying out of these soils is the possibility of salts rising to the surface. The chance location of a very alkaline profile near the camp site, which was examined during the September visit, raised doubts about this happening. However, after the examination of several more profiles along the edge of the Marsh it was clear that this original site was not typical of the effects of drying out of flooded land, but was only an example of the many salty and alkaline patches which are found on the banks of the Shire.

The texture of these soils is rather irregular although clays predominate, their depth varying, sometimes only one foot of clay being found before sand or sandy horizons are reached. Occasionally,

profiles consisting entirely of sand were located. The occurrence of these soils would have to be detected by a regular grid survey with augers, otherwise an undetected sand pocket would cause high seepage losses. An attempt was made to confirm whether the sand layer found immediately below the upper clay horizons was an original top soil, this being done by determination of the organic matter and nitrogen in these lower horizons, but no such conclusions could be drawn.

In reaction the soils of the area are generally neutral to slightly alkaline, only a few profiles showing slight acidity. In some instances, the soils become moderately alkaline at depth and occasional calcareous deposits containing up to 10 per cent. calcium carbonate have been located.

The base capacity of the soils follow closely their textures—as generally the organic matter content is only 2.4 per cent. although it does reach 8 per cent. in a few soils. These, however, are apparently in *dimba* or similar areas either on the island or the edge of the marsh. The nitrogen content of the top soils is therefore generally low, but the potential availability of both potassium and phosphate appears adequate.

Miscellaneous Soil Problems.

(*a*) A large estate reported that in a new plantation of blue-gums, there appeared to be better growth of the young trees along a line where there had been a stand of gums for several years previously. As blue-gums are supposed to be heavy feeders, and might therefore be expected to have an adverse effect on the soil, an examination of the soils of this area was made. From the resultant data the indications were that where gums have been grown previously, the fertility of the soil is not adversely affected. It appears that the improved growth thus noted may be due to the " mulching " effect of leaf fall enhancing its organic matter content. This will return nutrients to the soil, and will also increase the availability of those already there. The improved humus, will aid surface root formation, and in addition the " mulching " effect will lead to improved moisture retention in the soil. This is in contrast to the results of open cultivation as existed on the native gardens which adjoined the old line of gums, and on which the poorer trees now exist. It is therefore clear that if the beneficial effects of leaf fall are to be obtained after the clearing of gums, adequate steps must be taken to conserve the organic matter.

(*b*) Thirty-nine samples collected from the Fort Johnston area by the Ecologist were examined. All the soils are of rather low fertility when their texture and organic matter and nitrogen characteristics are considered. The phosphates are variable, depending on the mineralogy of the area. The potash supplies are generally satisfactory, as would be expected from the geology of this country. Their sandy nature indicates their low water retention.

(*c*) Other soils examined were from tobacco estates, and a Neno estate, where citrus was to be grown. It was interesting to note that it is proposed to improve the low fertility of the latter soil by application of bat guano—deposits of which occur on this estate. Analysis of this material showed it too low in nutrients to make it of commercial value—but where it could be used on the site it would be very beneficial.

Minor Elements.

With the Laboratory Technician on leave, work was reduced, just when it was becoming interesting and investigation of several problems, such as citrus dieback could not be undertaken. A summary of the data obtained since the 1953/54 Report is given below:—

TABLE IV

Parts per million

	Alu-minium	*Boron*	*Copper*	*Iron*	*Manga-nese*	*Molybde-num*	*Zinc*
Tea	320	—	—	380	340–1080	—	—
Tung (lower figures, N. Province) ..	—	60	8–16	—	530–720	0.2–1.6	18–48
Rhodes Grass ..	—	14	21	250–590	20–150	0.6–0.8	—
Dambo ,, ..	—	21	—	—	—	0.8	—
Star ,, ..	—	10	—	—	14	0.6	—

From the data on tung—confirmation was obtained of the explanation that previously noticed copper and zinc deficiencies in tung were largely due to morphological deficiencies in the soil—aggravated by drought conditions. Leaves taken from areas at the Tung station where deficiencies were apparent in 1950/51, now showed normal contents of copper and zinc.

CORRELATION BETWEEN SOIL ANALYSES AND PHOSPHATE RESPONSE

(Report of Agricultural Chemist, Agriculture Research Station, Chitedze)

In a paper (1952), Birch of E.A.A.F.R.O., showed that there was a significant inverse relationship between phosphate response and the percentage saturation of the base exchange capacity in certain East African Soils. This theory has since been applied to soils in Southern Rhodesia and to those used in certain fertilizer trials in Nyasaland, with little measure of success. In a later paper (1953), Birch showed that in addition there were also significant and inverse relationships between phosphate response and the amounts of citric acid soluble and water soluble silica in the soil.

In order to establish if these relationships existed in the soils of the Central Province and also with a view to making more accurate fertilizer recommendations, investigations were undertaken using soils on which maize fertilizer trials had been carried out during the 1954/55 season in various areas of the Central Province.

The results of this investigation are set out in the following Table.

TABLE V

Maize

Soil No.	*Location*	*pH*	*% Sat. of B.E.C.* (X_1)	*mg./100 g. soil Citric sol. SiO_2* (X_2)	*mg./100 g. soil water Sol. SiO_2* (X_3)	*lb/acre control yield*	*% response to P* (Y)
45	Chileka ..	5.9	67	220	42	1,220	21.8
78	Lumbadzi ..	6.3	85	190	38	4,118	16.3
29	Mpingu ..	5.5	58	470	90	2,995	14.1
27	Kasiya ..	6.4	71	—	—	2,305	6.4
17	Mponela ..	5.6	66	345	58	996	5.6
13	Nambuma ..	5.8	84	215	89	1,528	−1.5
21	Mkwinda ..	5.9	82	530	136	2,344	−2.7
37	Nsaru ..	6.1	83	400	65	2,204	−5.6
15	Nambuma ..	5.9	94	400	160	728	−6.8
23	Mkwinda ..	6.0	82	1,450	132	3,369	−8.5

In the above Table are the percentage increases in yield of plots having superphosphate above all those plots having no added phosphate.

The yield for the no phosphate plots was taken as the control yield.

The regression of phosphate response (Y) on the percentage saturation of the base exchange capacity (B.E.C.) X_1 was significant.

$$Y = -0.614X_1 + 51.1$$
$$t = 2.352^* \quad \text{(for P at 0.05 per cent. level, } t = 2.306\text{)}$$

The regression of phosphate response (Y) on the citric acid soluble silica (X_2) mg./100 g. soil was not significant.

The regression of phosphate response (Y) on the water soluble silica (X_3) mg./100 g. soil was significant.

$$Y = -0.187X_1 + 20.4$$
$$t = 2.812^* \quad \text{(for P at 0.05 per cent. level, } t = 2.365\text{)}$$

A significant and inverse relationship between percentage response to phosphate and control yield noted by Birch was not found, but this statement may be modified when more closely supervised experiments can be conducted.

Conclusions.

It would seem from these results that there is a possibility of relating chemical soil tests, to phosphate availability and response, for soils in the Central Province. The water soluble silica seems the most likely measurement to be of value in this respect and further investigations on these lines will continue during the coming year.

ROOT WASHING STUDIES

As a preliminary to the future investigation of soil moisture requirements of some of the major cultivated crops in Nyasaland, extensive root washing studies were carried out at Chitedze during the year, on maize, tobacco and groundnuts. This enabled a picture to be obtained of the effective root ranges of these crops and the soil volume occupied during various growth stages. As root area depends largely on soil type and the percentage available moisture in the soil, this aspect of the work with regard to moisture requirements is of extreme importance before any large scale moisture use study of any particular crop is contemplated.

The results showing the extent of root development at the end of the growing season are briefly summarized below.

Maize.

The main lateral roots comprising the shallower part of the root system developed early on, and the average lateral spread was from 2 ft. 6 in. to 3 ft. in all directions. These laterals then turned downwards either gently or abruptly, extending into the third or fourth foot of soil and often deeper. The main vertical roots were produced somewhat later and continued to develop until the plant was almost mature, being traced to depths of well below 6 ft. It can been seen therefore that the root system is very extensive and highly efficient.

Tobacco.

Secondary and tertiary lateral root spread was 15–18 in. from the centre of the plant along the ridge and after turning down these were traced to depths of up to 3 ft. 6 inches.

Groundnuts.

Lateral root spread was negligible in the bunch varieties and varied considerably in the spreading types up to a maximum of 2 ft. from the centre of the plant. In all varieties the taproot or secondary roots were traced to depths of at least 6 ft.

These figures provide a guide with regard to soil depths at which moisture changes can be expected in the soil profile during a normal growing season, and indicate where soil moisture testing cells will have to be placed in future soil moisture studies on the crops concerned.

PHYSICAL AND NUTRIENT STUDIES OF SOILS

(1) *Fertilizer Experiments.* Over 100 samples from various experiment Stations and native gardens in the Central and Northern Province were analysed and an attempt made to correlate the data obtained with fertilizer reponses.

Organic matter and nitrogen supplies in the Central Province were generally from medium to low, while in most soils from the Northern Province they ranged from low to very low. Available phosphate and phosphate reserves were at the medium level (25–50 p.p.m. for available and 50–150 p.p.m. for reserves using NH_4F, and NH_4F+HCe extraction respectively) but there was evidence that in some soils from the Northern Province, that these were not fully utilized due to fixation under acid conditions. Nearly all soils appear to have adequate supplies of potash.

The main need, especially in the Northern Province, would seem to be for an increase in the supplies of organic matter and nitrogen in order to make other nutrients more readily available.

(2) Tobacco Estates

(*a*) *Dark and Burley Tobacco.*

Some 80 samples were examined from various estates. The majority of them lay within the very slightly to moderately acid range. Texturally most of them were sandy clay loams and this appears to be the predominant textural class in the Lilongwe District. The organic matter status was generally from medium to low. Available phosphate supplies were only at the medium level and nearly always considerable additions were recommended. Potash supplies were good on the whole, though there was evidence of a shortage on some estates which had been established for a considerable time.

On nearly all estates the prime need was for a build up of organic matter and an increase in nitrogen supplies, in order that the soil nutrient status as a whole be improved.

(*b*) *Flue-cured Tobacco.*

Most of the samples examined were sandy loams with a high percentage of fine sand. As expected the nitrogen and organic matter status was from low to very low. Phosphate supplies were at the medium level, but potash tended to be somewhat low. There was evidence from the analyses that the addition of magnesite to preclude the possibility of " sand-drown ", was necessary on a number of soils.

Note.—*See* also under crops for other reports by Agricultural Chemists.

REPORT OF THE ECOLOGIST

Land Utilization Survey, Fort Johnston

A reconnaissance soil survey has been undertaken of the district as a preliminary to land utilization survey. The western side of the district and Nyambi areas having been covered by road and foot traverses in fair detail. Makanjila's shore and Jalasi remaining.

The district can be divided readily into the following divisions:—

(1) **Ciripa Plateau.** South of the Lake and between the two arms is a plateau area with ancient soil of the orange sandy clay type carrying *Brachystegia boehmii—B. manga* woodlands, generally speaking not occupied to any large extent by the local inhabitants. The occupied lands of the plateau fall into a red earth category and are closely settled.

Also in the plateau are various mountain or hill masses with shallow and immature soils of no immediate value for occupation. These include Pirilongwe Hill.

(2) **The Manjawila Escarpment.** Between the plateaux and the Lake-shore is a clearly defined escarpment with much broken country. The soils are red-brown in colour, heavy in texture but with high sand fractions. They are occupied in the neighbourhood of perennial streams and where there is sufficient depth of soil to warrant cultivation. It is an area of active present day erosion and presents a picture of much gullied and broken terrain.

(3) Below the escarpment is a broad **belt of colluvial soil** ranging in texture and colour but becoming grey-brown with distance from the escarpment foot. Occupation is fairly dense and much of the land cultivated by the Lake-shore dwellers is in this region. Some villagers have gardens five miles inland from the village.

(4) Behind the Lake-shore dune are areas of **pans** with thicket and glade vegetation. The soils are sandy in nature but cement to form hard pans.

(5) In the same situation but along drainage lines are heavy soils of the type described in the native language as " *makande* ".

(6) **The Lake-shore dune** is a sandy ridge varying in width and depth generally overlying colluvial deposits, these deposits often appearing as mud in the Lake itself.

(7) **Alluvial fans and belts** associated with the major river systems and characterized by *Acacia albida*. These areas are densely populated.

(8) **The Upper Shire and Malombe sand bars.** At the outflow of the Shire and at the northern end of Lake Malombe are sand deposits, grey in colour and often calcareous.

(9) **Kalembo Plain.** On the Kalembo Plain is a complex of soils falling into alluvia. colluvial, swamp and mopanosol categories. The two former groups are occupied and cultivated, cotton being a major crop. The swamp soils are heavy black clays whilst the mopanosols, carrying *Colophospermum mopane* are avoided by the native inhabitants as intractable.

(10) **The Nyambi Plateau.** The soils of the Nyambi Plateau are similar to the red earths of the Ciripa Plateau and demonstrate a clear catena of red earth, yellow-brown mottled and grey swamp soils. They are densely occupied. To the north of Nyambi is an area of strong-brown sandy soils and there are numerous hill and mountain outcrops.

(11) **The Eastern Escarpment** is very broken, with varied soil types. To the south the red-brown-gritty clay occurs and is to some extent occupied. To the north are red earth type soils.

(12) **The Jalasi Plateau** is similar to the Ciripa Plateau area with red earth and orange sandy clay soils, fully occupied. To the north are paler, sandier soils.

(13) **The Makanjila shore.** This area, although not studied in the field, has been subject to aerial photograph interpretation. There is a Lake-shore colluvial belt of greater or lesser width with very broken country to the east. At one place along the shore there is a stretch of much dissected dune country carrying cultivation.

(14) **East Malombe.** This side of the Lake has wide stretches of mopanosal country but with rich river valley areas of colluvial and alluvial soils. To the east, below the escarpment is an area of orange sandy clay.

LAND USE. An overall picture of the Fort Johnston District leaves no doubt that the better soils are all occupied and a land occupation map clearly demonstrates this point. There are a few European estates on the western side of the Lake and River on the Ciripa Plateau and several on the Eastern side. However, except for the Namwera and Nyambi area, it is doubtful if the area is over or fully populated. This point can only be deduced or derived from a population and garden survey.

AGRICULTURE, CROPS AND ACTIVITIES. The tribes of Fort Johnston District practice a rather haphazard system of agriculture. Crops of all types are likely to be found mixed in one garden or alternatively one garden is kept for one crop until the soil is exhausted.

Maize is the staple grain crop grown throughout the District. Along the Lake-shore area it is a marginal crop where climate statistics show a low rainfall area and the vegetation has affinities with the flora of semi-arid regions.

Sorghum is widely grown and generally ratooned. It is especially prevalent in Nyambi and in part of Kalembo.

Cassava is planted particularly near villages and not as a garden crop.

Groundnuts are well suited to most of the District and are extensively grown in Nyambi and Kalembo.

Cotton. There is room for extended cultivation of cotton especially on the alluvials of Mponda and Nankumba. It is grown in Kalembo's and East Malombe. The limiting factor is probably the grower, hindered by tribal custom. Women when questioned declare that groundnuts pay a better dividend.

Tobacco is suited to the red earths of Namwera, Ciripa and Nyambi. The orange sandy clays and paler soils of Namwera and Ciripa are reasonable for flue-cured tobacco.

Rice is cultivated in a variety of systems. In the plateaux areas, in seasonal swamps and in one particular place at hill foot seepage. Along the Lake-shore there are few areas of lagoon planted rice. In the Ciripa Hill area rice is planted in the river valleys.

Beans. A variety of beans are planted but not with success, the best being *Dolichos* which thrives on the Lake sands and on colluvials. The ground bean, *Voandzia* is found in Nyambi, *Cajanus* is planted in gardens as single planting or in permanent rows.

Vigna is late planted in Kalembo and said to give a crop.

Finger Millet is grown in separate gardens or mixed with maize or even rice.

Bananas, Pumpkins, Gourds, Bullrush Millet, Citrus, Coconuts, Sim Sim and *Sweet potatoes* are variously cultivated.

Fishing. Certain of the Lake-shore and river villages fish for subsistence and small profit. Fishing and garden activities often clash with agriculture, especially in early preparation of gardens and the situation should form a basis for a study of the proper division of fish and farming activities.

VEGETATION.

The vegetation shows marked zonations and the distribution of the communities reflects the effects of soils and climate. The following communities are readily recognized:—

(1) *Brachystegia boehmii—Brachystegia manga* woodlands on orange sandy clays.

(2) *Brachystegia tamarindoides* hill top and slope woodlands.

(3) *Brachystegia—Pterocarpus—Afrormosia* woodlands on red earths.

(4) Dense thickets and standards of dry hill foot and escarpment.

(5) *Sclerocarya—Capparidaceae* communities of colluvial shelf.

(6) *Adansonia—Cordyla* with understorey scrub.

(7) *Acacia albida* on recent alluvium.

(8) *Acacia xanthophloea* in small communities usually associated with semi-swamp conditions.

(9) *Hyphaene ventricosa* stands on Lake-shore sands and salty areas.

(10) *Ricinodendron rautanenii* on sands.

(11) *Piliostigma—Combretum—Acacia* on red earths of plateaux.

(12) *Albizzia harveyii—Dalbergia melanoxylon* on heavy soils marginal to and adjoining hard pan areas.

(13) *Euphorbia* thicket and glade associated with hard pan areas.

(14) *Colophospermum mopane* on mopanosols.

(15) *Terminalia sericea* on ancient Lake plain soils.

(16) *Diplorrhynchus—Brachystegia*—stony hill-foot woodlands.

(17) *B. busseii* hill woodlands.

(18) *Oxytenanthera abyssinica* brakes in hill country.

(19) Seasonal swamps.

(20) Perennial swamps.

(21) River communities.

WATER SUPPIES AND RIVERS. The Lake forms the main water supply for the villages of the Lake-shore and to some extent for several of the inland villages. Women have been seen carrying water from the Lake to villages several miles away.

The rivers of the area represent a dry aspect in the dry season and many of them only flow during heavy rain. This is especially so as they approach the Lake. Several rivers are perennial in their upper reaches.

Along some river courses are travertine deposits, Fort Johnston District being fairly rich in limestone deposits.

EROSION is most apparent in the escarpment areas where a gullied landscape follows natural erosion. The natural vegetation of the escarpment offers little protection to the soils.

The major rivers all have earth cliffs in their lower reaches, cut through alluvial deposits of varied composition. The Mtemangokwe and Gubudira have cliffs over 20 ft. tall. Consequent to the river bank erosion is sheet erosion from adjoining alluvial terraces especially where gardens are close to the river banks.

FORESTRY. There are in the western escarpment areas several areas where well-grown timber can be found and *Entandophragma* sp. were identified.

GAME. There is much evidence of Elephant in the peninsula and Kudu and lesser buck have been seen. They appear to derive sustence from shrubbery during the dry season.

N. LAKE CHILWA RICE AREAS.

Preliminary to and subsequent to the formation of a rice co-operative in N. Chilwa the area was examined for the suitability of rice production. The most promising areas for rice cultivation are the river mouth spill areas, where seasonal and perennial streams break through the ancient raised beaches of Lake Chilwa on to the present Lake plain.

Rice is also grown in the feeder swamps where it is more dependent upon the seasonal variations than that in the spill areas.

A trial sample census of gardens was attempted in the area to assess yields but owing to a conservative figure put upon the possible yield of rice per acre the tonnage arrived at was lower than that actually bought.

Experimental plots were put in areas other than those of the spill where the growers declared rice would not thrive, but in every case promising results were obtained.

A snag did arise, however, from the fact that a few cattle-owners are very careless in herding their cattle and allow them to damage rice grown close to the old beaches.

The area would pay for more detailed survey if rice prices are maintained. The people are rice-growers by tradition and have evolved a simple system of water flow control, the soils appear suitable and the fresh water inflow from the rivers counteracts salinity from the actual Lake.

BUSH CLEARANCE

The bush eradication trials using hormone weed killers were wound up, no satisfactory chemical or mode of application being discovered. 2–4–5 T in water and oil, 2–4 D, M.C.P.A. and Ammate were all employed, used at varying concentrations and applied at all stages in development of the *Pseudoberlinia—Brachystegia* scrub. Results were extremely disappointing and often plots displayed a greater number of woody individuals to the acre after treatment than before.

A series of practical plots were opened using cultivation practices in an attempt to destroy the scrub. So far stumping has proved the only effective method.

THORN SCRUB—KARONGA DISTRICT

The thorn scrub area of Karonga District lies to the south of the town and stretches for considerable distance along the low foothills and plain of the Lake-shore. It is generally found on good colluvial soils of a sandy loam nature, ideal for a groundnut, cassava, sorghum rotation and could, under irrigation, produce cotton.

The scrub itself is very conspicuous along the road, and this has been attributed to the herd-boys' preference for keeping the cattle on the road, especially in the wet season. That this is the primary cause of the scrub is not altogether clear as the observations will show but from a conservation and road usage point of view this prediliction for the road-side areas should be stressed as in need of remedy.

The Vegetation

The dominant trees of the area are various *Acacia* spp. and *Dichrostachys* spp. but there are also tall well-grown trees of *Sterculia africana*, *Tamarindus indicus*, *Kigelia pinnata*, *and Adansonia digitata*. These are particularly conspicuous in the garden areas nearer the Lake but are also widespread in the thorn communities. Close examination of the garden areas also reveals that thorns are there too, but kept under control by cultivation practices, and where present are by no means scarce. As one leaves the garden areas and proceeds towards the hills the *Acacia* and *Dichrostachys* become denser and more prominent and form the scrub which is the striking feature of the area. Beyond the scrub belt the *Acacia* spp. become taller and better grown and present a more parklike appearance.

The grass covers are, at the best, sparse throughout the whole area, but where there is an ample water supply, where the *Acacia* spp. are tall and well grown or where the grazing pressure is not high *Panicum maximum* is the March conspicuent, as in the better woodlands on the alluvial soils nearer Karonga itself. In the much grazed scrub the dominant grass is *Urochloa pullulans* which forms a sparse carpet which in places is so thin that sheet erosion is not checked in any way by the grass cover. Where in this area thorn trees protect the herbage from grazing *Panicum maximum* is present.

Where one finds neither grass there is a profusion of *Malvaceous* weeds of no grazing value.

Towards the hills the soils of the slight slopes become more and more stony until the surface is one of pure gravel. Along the foothills *Acacia nigrescens* assumes dominance on to the stony foothill soils, and the ground flora is one of annual grasses including *Heteropogon contortus*, the most vigorous, *Cymbosetaria saggitifolia*, *Aristida* sp., *Schizachyrium exile* and *Alloteropsis cimicina*. The herdboy, who acted as guide, said that in the dry season cattle were brought to the hills, but the grazing must be very sparse indeed and he probably meant into the better grown *Acacia spirocarpa* woodlands with fair *P. maximum* covers.

The hills themselves carry a poor scrub vegetation with *Pseudoberlinia globiflora*, *Brachystegia allenii*, *Terminalia* sp. *Commiphora* spp. and *Bauhinia petersiana*. Grass covers are poor but with occasional *Hyparrhenia filipendula* stands.

The Communities and Consituent Species

(*b*) *Garden areas*	Sterculia africana	Trichilia roka
	Kigelia pinnata	Hyphaene sp.
	Tamarindus indicus	Acacia subalata
	Acacia spirocarpa	Ficus sp.
	Panicum maximum	Rottboellia exaltata

The larger trees are often lopped by the cultivators at a level of 10 ft. to 15 ft. above garden level; the *Acacia* sp. are chopped off at ground level and are mostly present as regeneration.

Panicum maximum is an early invader of abandoned gardens.

(*c*) *Scrub areas*	Acacia subalata	vf.
	Acacia spirocarpa	vf.
	Acacia nigrescens	l—vf.
	Dichrostachys glomerata	vf.
	Dichrostachys nyassanum	o
	Hyphaene sp.	lf.
	Commiphora spp.	—
	Tamarindus indicus	o. tall tree
	Sterculia africana	o. tall tree
	Sclerocarya caffra	o. tall tree
	Combretum ghasalense	lf.
	Urochloa pullulans	d.
	Panicum maximum	l.

These communities vary from very dense, almost impenetrable scrub to thickets with open grassy glades; *Panicum maximum* is found under protective cover of *Acacia subalata* and *Urochloa pullulans* in the open grazed areas.

(c) *Thorn Parklands*	Acacia spirocarpa	v.
	Panicum maximum	d.

The trees are often closely grouped but are tall and present no scrub as obstacle to grazing. The ground cover is sparse but in patches is dense vegetatively and the fallen rubbish gives a cover to the soil.

(d)	Acacia nigrescens	vf.

Where *A. nigrescens* assumes dominance it is a tall tree, often associated with thickets and generally speaking on the stony soils at the foot of the foothill region. Grass covers vary according to site and soil.

Cymbosetaria saggitifolia	lf.	on stony soils
Enteropogon macrostachyus	f.	
Aristida sp.	lf.	
Heteropogon contortus	f.	
Digitaria sp.	d.	
Eriochloa sp.	l.	
Panicum maximum	f.	
Urochloa pullulans	vf.	

The Biological Aspect

Tradition rates the area as carrying tall, lower valley vegetation in the past and gives the thorn communities as a recent historical occurrence. This may well be true, and in part dependent on climatic changes, the thorn representing a community which is favoured by a drier climate in combination with increased human activity in the area. The tall *Tamarindus*, *Sterculia* and *Kigelia* certainly give an impression of greater age than the thorn.

The original thorn vegetation may have been of the type now represented by the thorn parkland phase.

The present scrub vegetation is a result of abandonment after cultivation and subsequent cattle grazing.

In the 1914–1918 war, considerably larger areas were under cultivation than at present and it is in these areas that scrub is most prevalent. In the present garden areas the thorns are kept back by cultivation and generally speaking do not reach any great size. Of course there are individual trees left here and there. Where the cultivations cease there is thorn scrub and this applies to the areas of cultivation along the rivers as well as on the plain. The cattle no doubt played a part in the establishment of this scrub but abandonment of wider spread cultivation must also be considered.

The cattle are dependent on the thorn for sustenance in the dry season in the form of edible pods and by eating the pods and spreading undigested seeds in their droppings, account for dense establishment of seedlings. Under full grown *Acacia* woodland, nearer the foothills, seedlings appear to be shaded out by competition or are burned off by grass fires. It is in the garden areas where they have most chance of establishment.

VIPYA UTILIZATION AND THE NATURAL VEGETATION

The vegetation of the Vipya highlands can be described as a succession of types from evergreen palaeoclimax forest to grassland, initiated by fire destruction and followed by soil deterioration. The result is that evergreen forest is left as relics in fire sheltered pockets, as isolated patches and as rapidly degenerating spinneys.

The community in the immediate vicinity of evergreen forest is generally a tangled mass of woody herbs often associated with *Pteridium* and *Hyparrhenia cymbaria* which may be very localized or somewhat widespread or even the last relict of a spinney patch. The grass community with *Hyparrhenia cymbaria* may be widespread but is usually confined to the forest borders and to sheltered concave valleys.

The *Themeda triandra var. hispida* phase represents the next stage in degradation and is found on the gentler slopes and in areas which have carried forest in the not too distant past.

The poorer phases are represented by *Andropogon schirensis* grassland on the exposed slopes and ridges.

There is one poorer phase still, which is relatively rare on the Vipya but common on the Nyika, and that is the type dominated by *Monocymbium cerisiiforme.*

Diagramatically the communities can be represented thus:

Palaeoclimax	Scrub	*Hyparrhenia*	*Themeda*	*Andropogon*	*Monocymbium*
forest	margins	*cymbaria*	*triandra*	*schirensis*	*cerisiiforme.*

The downgrade is from forest to short, tufted grassland and is caused by a complex of factors having in common a deterioration in the habitat factors, *i.e.* shallow soils, exposure, erosion, time elapsed since destruction of forest.

From the utilization point of view the now accepted use of the montane grassland is for afforestation with *Pinus* which will grow on the soil of the *Andropogon schirensis* phase but there are left the better *Themeda triandra* and *Hyparrhenia cymbaria* grasslands. The former will present marginal conditions and may well be better suited to afforestation where they adjoin the *A. schirensis* type. However, where the *Themeda* merges with the *Hyparrhenia cymbaria* or where it is marginal to evergreen forest or in a sheltered valley then it should be capable of coffee growing. The *Hyparrhenia cymbaria* grassland should be similarly utilized. Should coffee be grown on these sites its culture would protect the remnants of evergreen forest from further fire encroachment as the coffee belts would constitute firebreaks; it would provide an extra inducement to permanent labour for the forestry projects if the workers were also allowed to work allotments for coffee gardens for personal profit; it would provide a cash crop for that particular area of Northern Province.

Thus, any survey of areas for utilization should demarcate the grassland types as given above, so that potential coffee garden areas can be assessed for acreage and possible yield.

As most of the sites will be on concave valley slopes terracing will be essential for soil conservation.

A second possible site for coffee planting which could be considered in co-operation with the Forestry Department is within the relics themselves. This could be practised on a corridor principle and there is evidence from the Nchisi area for its success.

A PRELIMINARY ACCOUNT OF THE BOTANY AND ECOLOGY OF THE ALIMENDA DISTRICT

Two main types of plant community are represented, edaphic, seasonally waterlogged-grassland and woodlands which vary from tall climax to semi-parkland and scrub.

(1) **Edaphic Grasslands.** These communities are found along the river banks where there is seasonal water logging with the result that trees are unable to survive. The soils appear black and heavy in the wet season and are designated "*dambo soil*" on the soil survey map.

(*a*) *Ischaemum brachyatherum—Setaria palustris* open tall grassland represents the highest type of seasonal swamp grassland and does extend into the margins of the woodland where the soils are liable to waterlogging. *Ischaemum* is the indicator rather than *Setaria* as the latter is found through all the stages to tall woodland.

(*b*) *Sporobolus robustus* open, tall grassland with a somewhat discontinuous distribution, thought to follow incipient salinity. Cover is low, about 15 per cent., although herbage may be 48 ins. tall in leaf and higher in flower.

(*c*) *Sporobolus sp. nr. marginalis* (G.J. 1,206) short, open grassland patches indicative of extreme salinity. Stems and leaves taste strongly of salt. Tufted, low, about 6 ins. tall, with inflorescences

up to 36 ins. Cover, higher than in adjoining grasslands is about 40 per cent. The stand clearly shows effects of sheet erosion as fossil tufts of last season's growth are left standing above present soil surface on their roots.

The foregoing types of grassland are natural and edaphic and arise under natural conditions. Community (*a*) may be sole community in any area but (*b*) and (*c*) are usually found in association with (*a*) as a mosaic of types. This is particularly the case with the Alimenda *Dambo*.

(*d*) In the north of the concession there is a different type of swamp grassland where *Panicum repens* is the conspicuent in the month of February. It is associated with marginal *Hyphaene* palms and would in a normal season be very wet.

(*e*) Other types do exist in special areas.

Pennisetum purpureum and *Echinochloa pyramidalis* where there is a perennial water supply or alluvial soils.

(*f*) *Echinochloa stagnina* and *Echinochloa haploclada*, marginal to and into the water of the rivers and swamps.

(*g*) *Chloris gayana* in considerable stands with the *Ischaemum-Setaria* communities and into the cultivated lands subject to annual flooding.

(2) **Woodlands.** This category includes all communities that cannot be classified as true edaphic grassland.

(*a*) *Climax Vegetation.* The tall woodland types, in the area south of the Mwanza River, most probably represent the climax vegetation of this region where fire and cultivation in the distant past have removed the paleaoclimax of evergreen forest. Typical trees include the very conspicuous *Sterculia appendiculata*, (*Njale*) with the smooth light yellowish trunk and rounded crown, *Tamarindus indicus*, *Cordyla africana*, *Kigelia pinnata*, *Sclerocarya caffra* and occasionally numbers of *Adansonia digitata*. The Knobthorn, *Acacia nigrescens* is widespread but not conspicuous. The grasses are tall and in February the conspicuents are *Setaria palustris* and *Panicum maximum*.

Cultivation methods in such country are today rather drastic, owing to large numbers of indigenous cultivators in any one area. The large trees are cut down and destroyed, bush cleared and the tall woodland becomes an open garden with the odd tree left standing. This is particularly conspicuous where gardens are cut into a stretch of hitherto well-regenerated woodland.

Under a system of shifting cultivation, low populations and small clearances, such gardens would have normally been abandoned after a few years and allowed to regenerate. Nowadays, however, pressure in one area is so great that soil deterioration appears to proceed more rapidly than the ability of the constituent species to regenerate and the result is several new communities.

(*b*) *Acacia nigrescens* parkland. Towards Ngabu and south of Jombo there is an area of parkland with scattered *Acacia nigrescens* and evenly distributed thickets with *Dalbergia melanoxylon*, *Strychnos* spp. and semi-evergreen relic bush on and around ant-hills. The soils are brown, compacted sandy loams.

(*c*) *Dalbergia melanoxylon* thickets on all grades of soil, even as a pioneer species at the black *dambo* soil margins. The conspicuousness of this species as a thicket former in large areas is probably a function of the ease of regeneration from the copious seed crops set.

(*d*) *Combretum ghasalense* is found as dominant small tree in areas with heavy soil, liable to flooding in a normal wet season. Found particularly north of Ngabu on the south boundary of the concession.

(*e*) *Acacia xanthophloea* found in occasional stands where there is underground and probably flowing water. Usually seen by rivers but found elsewhere under the circumstances above.

(*f*) There are other stands of trees including *Acacia subalata*, *Colophospermum mopane* just on the edge or beyond the western boundary of the concession; *Lonchocarpus capassa*, found in the cut out country but in fair numbers by the Chimbeya River;

Hyphaene ventricosa is also found in regenerating stands in the north of the concession where mature trees have previously been tapped for the sap by the indigenes.

Ecology. The edaphic grasslands present no difficulty and are areas where grassland is determined by the seasonal water table.

The woodland and biotic grasslands, hitherto classed as parkland, semi-parkland and open grassland are less easy to define. However, it is evident that much human activity has taken place in the Lower River area in the past and the picture becomes more clear when the human element is brought into it.

The parkland proper, as defined by previous observers is the tall woodland with well-grown trees, a climax brought about by small scale destruction of forest by shifting cultivation and whole sale prevention of evergreen forest regeneration by fire and possibly by change in continental climate.

With increased population and human activity the woodland is selectively felled to give parkland or semi-parkland effects with deterioration of soils following cultivation on a large scale.

Finally, as a result of very heavy occupation and continued cultivation, there succeeds a biotic grassland with occasional scattered trees, such as Baobab groves, shade trees and trees of religious significance. The soils are very deteriorated and carry only *Urochloa pullulans* var. *mosambicensis*, a grass which readily colonizes old garden sites and sets copious quantities of viable seed.

The biotic grasslands often overlap the edaphic grasslands, and borderline cultivations would carry *Urochloa pullulans* var. *mosambicensis* even on the seasonal swamp margins.

Urochloa in pure stand thus indicates deterioration of soil which is also a sandier phase by virtue of the removal of the clay by sheet erosion. *Urochloa* is, however, found on heavier soil as a cultivation weed and next to and amongst stands of *Setaria palustris*.

Evidence of wide scale settlement and sheet erosion are not hard to find in the Lower River, as large areas are veritable kitchen middens with many littered potsherds of types not used today, bones, beads and charcoal in the soil. Trees sit above the surface of the soil on their roots, and old anthills, even with vegetation, show a good measure of erosion.

The ecology at first sight does not give much evidence of soils suitable for irrigation but points a warning about the dangers to the soil under annual cropping, which would be avoided to a degree by the system of irrigation trenches.

The other point, made clear by the ecology of the seasonal swamps, is the ease with which salt pans are forming naturally, especially where the large Alimenda *Dambo* shows the clear mosaic of types over a large area.

A paper, "*Preliminary Ecological Survey of Nyasaland*", was presented to the 2nd Inter African Soils Conference at Leopoldville. (Pro. 2nd. Inter African Soils Conference 1954, pp. 679–690.)

HERBARIUM. There are now over 2,000 specimens in the Zomba collections many of which have been authoritively determined at Kew; the Imperial Forestry Institute, Oxford; the British Museum; Salisbury Herbarium and Brussels.

COTTON RESEARCH IN NYASALAND, 1954/55 SEASON

BY H. C. DUCKER, COTTON SPECIALIST, E.C.G.C.

INTRODUCTION

In the Southern Province, and particularly in the Lower River, the rains broke early and falls were heavy. Many parts of the Lake-shore area of the Central Province, however, experienced their third successive year of shortfall in rain and at the Chitala Station the planting rains were especially sparse and difficult. The season generally was not favourable for cotton, which made excessive growth in the wetter areas, while at Chitala growth was stunted by the very short growing period. In the Karonga area the winter cotton crop suffered from poor floods in the 1953/54 season, although the variety trial there gave excellent returns.

VARIETY TRIALS.

A trial of long-staple Upland varieties was carried out at Kafikisila near Karonga, the results being given in Table I below:—

TABLE I

Variety	Yield per acre in lbs. Seed-cotton	Lint.	% Grade 1
C.L.B. Karonga	1,742	562	98.5
47/10 ex Tanganyika	1,914	559	,,
C.L.A. ex Tanganyika	1,654	505	,,
C.L.20 ex Chitala	1,474	468	,,
B.P.52 (C.50/20)	1,241	391	,,
Wilds No. 11 ex Sudan	1,175	382	,,
STANDARD ERROR	±74	±23	

The excellent conditions provided by winter cropping, with its virtual absence of pests and diseases, are confirmed. The trial is being repeated and the crop is promising. Further development with the commercial crop of Karonga must depend on work with flood control and irrigation, the possibilities of which are being investigated this year.

Six strains of " Albar 51 " selected at Chitala last year as high ginners and looking promising in the field, were compared with C.L.B. and C.L.20 as control types, in trials at Chitala, Makanga and Ngabu. Results are given in Table 2

TABLE II

Cotton Variety Trials, Southern and Central Provinces

(*Yields in lb. lint per acre*)

Variety	Chitala	Makanga	Ngabu
Albar 51–625	193	235	297
,, –629	166	156	253
,, –637	209	303	268
,, –639	237	382	270
,, –640	194	222	228
,, –645	217	239	261
C.L.B.(s) —	160	112	107
C.L.20 —	152	90	140
STANDARD ERROR	±18	±19	±28

The seed used in these trials was not treated with bactericide and at both Lower River Stations severe stem lesions, due to bacterial blight, were noted on C.L.B. and C.L.20. The disease was not so serious at Chitala, but at all three stations Albar 51 has showed to advantage beside the local cottons. Any damage to the bolls by bacterial blight was, however, completely swamped by stainer-carried *Nematospora* infection. Ginning out-turn was considerably higher with the Albar 51 than with either of the local types at all centres.

BACTERIAL BLIGHT.

The commercial crop of the rain-fed areas was all sown with Perecot treated seed and the general healthiness of the young plants was markedly good in all areas. Observations showed, however, that the very wet conditions in the Southern Province encouraged later infection and the performance of C.L.B. compared with more resistant Albar 51 strains in the varietal trials is suggestive.

Direct trials of Perecot-dusted versus untreated seed on a statistical basis were confined to Chitala and results are given in Table 3 below. Duplicate experiments superimposed on bulks of C.L.20 and C.L.20 Filter Bulk were laid out but the late season made counts difficult.

TABLE III

Effect of seed treatment on Bacterial Blight incidence and yield

	Dusted Seed			*Untreated Seed*		
	C.L. 20	*C.L. 20 F.B.*	*Mean*	*C.L. 20*	*C.L. 20 F.B.*	*Mean*
Mean infection % of population (all leaf and stem phases):						
(*a*) Counts at 15/2/55 ..	1.0	2.4	1.7	5.6	4.7	5.1
(*b*) „ „ 12/3/55 ..	4.6	8.2	6.4	23.5	11.0	17.2
Seed Cotton Yield, lb. per acre ..	272	462	367	272	511	391

Leaf and stem infections were significantly lower with Perecot at both counts, but the final yield differences were not significant.

New Selections.

With the help of the officers in charge of Makanga and Ngabu Stations, hereby gratefully acknowledged, a large range of single plant selections, of C.L.B., S. and C.L.20 parentage, has been obtained. Plots of these varieties at each station were thinned to single plants and seed cotton from the earliest pickings only was retained for examination. It was hoped to emphasize the ginning shortfall to the utmost and so facilitate reselection for higher ginning material.

Some success was achieved with C.L.B., but it early became obvious that there is insufficien variation in C.L.20 to make reselection worth while. There is no future for this variety in the Lower River under the new regime, except possibly as a parent in crosses. Stainer and Nematospora damage to the seed made it necessary to discard a large number of the single plants of both varieties, but 113 C.L.B., S., selections have been retained for field study in 1955/56. A minimum G.O.T. of 32.5 per cent. under Lower River conditions coupled with a minimum halo length of 27 m.m. form a general basis for selection, inferior values being discarded.

Crosses of Albar 49 with B.P.52 and C.L.20 in various arrangements have been in panmixis at Chitala since 1952. They have been heavily rogued for Jassid and bacterial blight susceptibility and this year single plants have been selected from the F4 material. About the same range of G.O.T appears as in C.L.B., S. but, as might be expected, halo lengths are in general a millimetre or so longer. It is unfortunate that no direct testing of bacterial blight resistance has been possible, but it is believed that the best of this material is every bit as good as the best of the Albar 51 lots and that Jassid resistance is higher in the crosses.

EXTRACT FROM AGRICULTURAL CHEMIST'S REPORT

Cotton Seed.

The examination of seed cotton from the markets, as detailed in last year's Report was completed.

Moisture and F.F.A. determinations were made on 130 seed cotton and cotton seed samples, taken during the season. The distribution and acidity followed the pattern given for the first 92 samples included in 1953/54 Report. The acidity figures referred to per cent. F.F.A. in the oil, the per cent. in the seed thus being approximately one-third of these figures.

From the graph of F.F.A.—moisture figures, it was seen that although the correlation coefficient is only 0.37 (Significant between P 0.05 and 0.02), there is a definite indication that high moisture induces high acidity.

In addition, a check was made on the moisture and acidity changes of seed in the stores. Seed was taken from the top, middle and bottoms of the pile of bags and examined. The following results were obtained:—

Relationship of Acidity and Storage Condition

	Outside		*Middle (3')*		*Bottom*	
	Per cent. moisture of kernel	*F.F.A. per cent.*	*Per cent. moisture*	*F.F.A. per cent.*	*Per cent. moisture*	*F.F.A. per cent*
Chiromo 20/5	7.3	1.2	8.0	2.2	6.1	2.1
,, 31/7	7.5	2.7	8.5	3.2	7.0	2.9
,, 24/8	7.2	3.2	7.9	2.7	7.5	3.0
Mitole 30/7	8.1	2.1	9.5	4.0	7.8	3.1
Maperera 31/7	8.0	3.0	8.2	2.6	8.9	4.6

Further storage tests were made in open and closed containers under different temperature and humidity conditions. The temperature tests gave the following results after $2\frac{1}{2}$ months' storage:—

Stored in	*Per cent. moisture in kernel*	*Per cent. acidity of oil*
(1) Lab. (open container)	8.4	1.9
(closed ,,)	7.4	2.8
(2) Refrigerator (open container)	11.8	2.9
(closed ,,)	7.6	3.9
(3) Outside (open container)	14.8	3.3
(closed ,,)	7.1	2.9

The officer who took the samples reported that the cotton seed at the base of the store was noticeably hotter than at the top.

In the humidity part of the experiment, the results are given below, all the seed being stored at room temperatures for three months.

Seed stored at	*Moisture content of seed*	*F.F.A. in extracted oil*
32% Rel. humidity	7.3%	1.2%
47% ,, ,,	8.3%	2.0%
66% ,, ,,	10.1%	2.4%
81% ,, ,,	11.2%	4.4%.

Considering these figures, with the " temperature " results it appears that dampness of air is of more importance than temperature in promoting hydrolysis.

From these results the following conclusions are apparent:—

1. Seed cotton, when purchased for store, should be as dry as possible. From the Equilibrium Moisture determinations, it was found that seed dried to 10 per cent. moisture content took over one week to reach their equilibrium moisture state at humidities greater than 90 per cent. Sundrying will, therefore, overcome the effect of higher humidities in the early morning.

2. Seed in store should be well ventilated by stacking in sections with air circulating freely round the seed. The sacks should also not be too tightly filled.

3. As the relative humidity on the Lower River area is 80–90 per cent. in the early morning but only 40–60 per cent. at 2 p.m. it is advisable to instal covered ventilators or fans so that the drier afternoon air may be admitted to dry the cotton, but the ventilators can then be closed to the damper air of the morning and evenings.

4. Stores and particularly roofs to be painted with reflecting paint, *e.g.*, aluminium paint.

The same rigid control of markets was not repeated in the 1955 season, and in addition the cotton buying period was much wetter than in 1954. Consequently a proportion of seed deteriorated in store. Such samples from store at Chiromo, Maperera and Mitole were examined for

quality. While the seed at Chiromo was reasonably good, containing only 14 per cent. by weight of poor seed, the material at the other two stores contained 35–40 per cent by weight of poor seed containing 40 per cent. F.F.A. This resulted in the extracted oil having an F.F.A. content of 17 per cent., as against 5 per cent. in oil from the Chiromo seed. The poor seed would, therefore, only give 9–10 per cent. of refined oil, and this figure would probably be lower, as on expression the F.F.A. would increase beyond that found by solvent extraction.

It is clear, therefore, that improved storage facilities are required. Although a drying unit would assist initial drying—this would have to be associated with some form of store under controlled humidity and temperature conditions, otherwise the seed would soon pick up moisture from the atmosphere.

TOBACCO

Dark Fire-cured Tobacco

Varietal Improvement.

At the Tuchila Experimental Station the variety "Western" gave the highest return per acre. It had been hoped that one of the three selections (C1/14/A, C3/42/A/A, T9/A/A) out of "Western" which have shown promise in the past would prove superior to "Western" but this did not occur.

TABLE I

Variety Trial on Dark Fire-cured Tobacco

Variety	*Yield lbs/acre*	*Value/acre* £ s d	*Value/lb. d*	*Grade Index*	*Crop Index*
Chitedze Western	954	21 4 4	5.3	55.1	52,565
Tuchila Western	860	19 12 3	5.5	59.2	50,912
Lingadzi	989	19 11 10	4.8	49.8	49,252
C1/14/A	880	18 7 7	5.0	53.0	46,640
C3/42/A/A	848	17 12 4	5.0	54.1	45,877
Little Crittenden	817	16 18 2	5.0	53.9	44,036
T9/A/A	907	16 5 10	4.3	47.6	43,173
Greenwood	765	14 11 1	4.6	47.4	36,261
Brownleaf	675	13 18 5	4.9	52.1	35,168
L.S.D. (P=0.05)	153	4 18 10	—	6.7	—

Minor Elements.

A Minor Element Trial in which magnesium, copper and zinc were applied at different levels and in all combinations was done at Chitedze to investigate the need for one or more of these elements in our soils. As shown in Table II, magnesium in the form of magnesite, just failed to increase the Grade Index significantly, copper, applied as copper sulphate, was not significant at all, and zinc, applied as zinc sulphate, gave a significant increase in the Grade Index only.

TABLE II

Minor Element Trial on Dark Fire-cured Tobacco

Magnesite

	Nil	40 *lbs/acre*	80 *lbs/acre*	*L.S.D. (P=0.05)*
Lbs./acre	589	600	593	32
Grade Index	28.4	29.7	28.8	1.4
Crop Index	16,698	17,832	17,067	—

Copper Sulphate

	Nil	15 *lbs./acre*	30 *lbs./acre*	
Lbs./acre	595	585	603	32
Grade Index	29.1	28.5	29.2	1.4
Crop Index	17,338	16,655	17,632	—

Zinc Sulphate

	Nil	15 *lbs./acre*	30 *lbs./acre*	
Lbs./acre	587	596	600	32
Grade Index	28.4	30.0	28.5	1.4
Crop Index	16,653	17,874	17,094	—

Priming and Number of Leaves.

Two trials were done: one at Chitedze and the other at Tuchila. If the Tuchila results are examined in conjunction with the note referring to that trial it will be seen that it paid to prime at both places.

An examination of both trials indicates that plants with a mean of 8.5 to 9.5 leaves per plant are likely to give the most economic return per acre.

TABLE III

Response to Priming and Number of Leaves on Dark-Fired Tobacco at Chitedze

Priming

	Nil	3–4 *leaves*	6–8 *leaves*	*L.S.D.* ($P=0.05$)
Lbs./acre	596	616	496	66
Grade Index	22.1	30.1	28.7	3.6
Crop Index	13,172	18,542	14,235	—

No. of leaves

	7.3	8.7	10.3	—
Lbs./acre	491	577	639	66
Grade Index	25.9	27.0	28.0	3.6
Crop Index	12,717	15,579	17,892	—

TABLE IV

Response to Priming and Number of Leaves on Dark-Fired Tobacco at Tuchila

Priming

	Nil	3–4 *leaves*	6–8 *leaves*	*L.S.D.* ($P=0.05$)
Lbs./acre	1,268	1,534	1,394	125
Grade Index	44.5	42.6	51.1	3.7
Crop Index	56,426	65,348	71,233	—

No of Leaves

	7.6	9.4	11.0	—
Lbs./acre	1,299	1,422	1,474	125
Grade Index	48.1	46.5	43.6	3.7
Crop Index	62,482	66,123	64,266	—

Note.—All "nil treatments" at Tuchila were primed in error. If these leaves had not been primed it is reasonable to believe the nil plots would have shown a higher yield per acre and that a large part of this increase would have been low grade leaf. It follows that the presence of this low grade leaf would have lowered the Grade Index and the Value/lb. for the treatment.

Dark Sun/Air cured Tobacco

Time of Planting and Nitrogen.

In a year with normal distribution of rainfall the earlier plantings can be expected to do better than the later planting. This year's trial at Chitedze again proves this point. The outstanding gain this past season from early planting was in the quality of the cured leaf.

With the expectation that the fertilizer companies will soon be putting out 50-lb. pockets of sulphate of ammonia, applications of 50 lbs. per acre were tried at Chitedze for the first time. The results were not significant while 100 lbs./acre gave a significant increase in yield as in the past.

TABLE V

Response to Time of Planting and Nitrogen on Dark Sun/Air Cured Tobacco

Time of Planting

	12th Dec.	*27th Dec.*	*10th Jan.*	*L.S.D.* ($P=0.05$)
Lbs./acre	543	592	439	89
Grade Index	26.1	15.2	10.4	3.7
Crop Index	14,172	8,998	4,566	—

Sulphate of Ammonia

	Nil	*50 lbs./acre*	*100 lbs./acre*	
Lbs./acre	454	534	586	89
Grade Index	16.2	16.2	19.3	3.7
Crop Index	7,355	8,651	11,310	—

Dung and Method of Placement.

A trial was done at Chitedze in which Farmyard Manure was compared with *Khola* Manure and different methods of placement were tested.

Both forms of Dung gave a significant increase in yield and Grade Index, but the method o placement was not significant.

TABLE VI

Response to Dung and Placement on Dark Sun/Air Tobacco

	Nil	*5 tons/acre F.Y.M.*	*5 tons/acre khola Manure*	*L.S.D.* ($P=0.05$)
Lbs./acre	371	461	492	57
Grade Index	35.7	43.7	44.2	4.6
Crop Index	13,245	20,146	21,746	—

Method of Placement

	Dollop at side of plant	*Mixed at planting station*	*Banded under ridge*	*L.S.D.* ($P=0.05$)
Lbs./acre	453	440	430	57
Grade Index	41.2	41.3	41.0	4.6
Crop Index	18,664	18,172	17,630	—

Time of Maturity.

A Time of Maturity trial was done at Chitedze. The object was to determine what the appearance of leaf was at that stage which gave the highest return per acre and to note what number of days after topping this leaf was harvested.

The treatments in which cropping commenced at 24 days after topping gave a highly significant increase in Grade Index, and almost double the return per acre obtained from other treatments.

TABLE VII

Time of Maturity Trial on Dark Sun/Air Tobacco

Leaf Cropped at Different Number of Days after topping

Days after Topping	*16*	*20*	*24*	*28*	*33*	*L.S.D.* ($P=0.05$)
Lbs./acre	573	510	590	612	658	90
Grade Index	11.5	11.1	23.0	13.5	10.1	2.7
Crop Index	6,590	5,661	13,570	8,262	6,646	—

The object of this experiment was to show the effect of crop on crop with and without fertilizer. The cycle was a two-year one and was completed at Chitedze and Tuchila this past season.

At both Chitedze and Tuchila, tobacco did significantly better when planted after groundnuts.

Fertilizer, applied on the preceding crop, gave no significant increase in Yield or Grade Index on the crop which followed it.

TABLE VIII

Mean Effects of Previous Crop on Dark Tobacco at Chitedze

	Maize	*Maize and Beans*	*Groundnuts*	*Tobacco*	*L.S.D. (P=0.05)*
Lbs./acre	411	409	502	376	83
Grade Index	33.9	29.0	31.3	31.2	5.8
Crop Index	13,933	11,861	15,713	11,731	481

TABLE IX

Mean Effects of Previous Crop on Dark Tobacco at Tuchila

	Maize	*Maize and Beans*	*Groundnuts*	*Tobacco*	*L.S.D. (P=0.05)*
Lbs./acre	659	583	718	646	77
Grade Index	49.2	49.3	53.8	51.1	5.4
Crop Index	32,423	28,742	38,628	33,011	416

SPACING AND NO. OF LEAVES

Two trials, done in 1952/53 and 1953/54, were examined to determine what effect closer spacing and leaving more leaves on the plant had on the grades of leaf 23 ins. long and over. The yields per acre given below are for the 1952/53 trial. Those for the 1953/54 trial are in agreement.

TABLE X

Showing the Effect of Spacing and Number of Leaves on Dark Grades of Tobacco 23 inches long and over

	SPACING		
	3 ft. × 2 ft.	*3 ft. × 3 ft.*	*3 ft. × 4 ft.*
Wrapper 23″ and over (lbs./acre)	184	163	176
Filler 23″ ,, ,, (lbs./acre)	123	142	89
Total leaf 23″ and over ,, ...	307	305	265
Per cent. filler 23″ and over	40	47	34
Yield/acre, all grades	1,196	879	722
Per cent. 23″ and over	26	35	37

	NUMBER OF LEAVES		
	7	*8*	*9*
Wrapper 23″ and over (lbs./acre)	198	164	160
Filler 23″ ,, ,, (,,)	102	96	155
Total leaf 23″ and over (,,)	300	260	315
Per cent. filler 23″ and over	34	38	49
Yield/acre, all grades	809	932	1,056
Per cent. 23″ and over	37	28	30

It will be seen that with closer spacing the yield per acre has increased and the percentage of leaf 23 ins. and over has decreased, though the total amount of this long leaf is not much affected by the spacing.

Increasing the number of leaves from 7 to 9 has given an increased total yield but has made little difference to the amount of long leaf produced.

VARIETAL IMPROVEMENT.

In a replicated trial, done at Chitedze, the popular variety Stand Upright gave significantly better results than all other varieties except Kelley and Green Briar. The latter is the Canadian variety grown in Canada for the export market.

Barnet Special, while not outstanding in the trial, was of interest to a number of growers who tried some last year and were impressed with the texture of its leaf.

TABLE XI

Variety trial on Burley Tobacco

Variety	*Yield lbs./acre*	*Grade Index*	*Crop Index*
Stand Upright	775	41.89	32,465
Kelley	721	40.06	28,883
Kentucky 41	850	33.14	28,169
Haronova	839	32.11	26,940
Harmony	893	29.80	26,111
Mm.Ky.22	807	31.51	25,429
Harrow Velvet	785	29.74	23,346
Green Briar	667	34.94	23,305
Briarvet	721	32.30	23,288
Ky.16	721	32.29	23,281
Ky.19	775	29.36	22,754
Gays Yellow	656	33.14	21,740
Station Standup	689	30.91	21,297
Harrow Broadleaf	721	28.60	20,621
Barnet Special	639	31.53	20,148
Ky.35	742	26.03	19,611
Burley 1	699	27.84	19,460
Halley's Special	645	29.93	19,305
Ky.22	613	30.85	18,911
Judys Pride	624	30.29	18,901
B.M.I.	753	23.75	18,359
Ky.41A	721	24.79	17,874
Haronic	624	25.91	16,168
Broadleaf Resis.	796	19.95	15,880
Ottawa Strain 50,194	721	20.79	14,990
L.S.D. (P=0.05)	203	7.68	—

FERTILIZER TRIAL.

Last year's fertilizer trial in which the major elements, nitrogen, phosphate and potash were tested, was repeated during the past season. The only change in the trial was the substitution of three methods of phosphate placement for three different spacings.

It will be seen in Table XII that 300 lbs. sulphate of ammonia gave a highly significant increase in both Yield and Grade Index, that 150 lbs. superphosphate gave a significant increase in both Yield and Grade Index but that more than this amount of superphosphate gave no further increase, and that while Yield and Grade Index increased with the addition of potash this increase was not economical.

Method of placement of the phosphate was not significant.

This trial is of particular interest in that the trial done last year on a very much better soil showed no response to applications of phosphate and a negative response to potash, and the chemical analyses for both these soils are in agreement with the results of both these trials.

TABLE XII

Major Element Trial on Burley Tobacco

Sulphate of Ammonia

	Nil	*150 lbs./acre*	*300 lbs./acre*	*L.S.D. (P=0.05)*
Lbs./acre	506	748	963	47
Grade Index	25.9	41.7	51.2	2.6
Crop Index	13,105	31,192	49,306	—

Superphosphate (19 per cent.)

	Nil	*150 lbs./acre*	*300 lbs./acre*	
Lbs./acre	714	766	738	47
Grade Index	35.6	41.7	41.5	2.6
Crop Index	25,418	31,942	30,627	—

Sulphate of Potash (48 per cent.)

	Nil	*150 lbs./acre*	*300 lbs./acre*	
Lbs./acre	710	741	767	47
Grade Index	38.6	39.7	40.4	2.6
Crop Index	27,406	29,418	30,987	—

Method of Placement

	Dollop side of plant	*Mixed at planting station*	*Banded under ridge*	
Lbs./acre	753	730	735	47
Grade Index	40.1	38.9	39.7	2.6
Crop Index	30,195	28,397	29,180	—

Turkish Tobacco

Experimental work on this type of tobacco is still in the observational stage. Different times of planting were tried at Mbawa, in the Northern Province, and at Lisasadzi and Chitedze, in the Central Province. These trials, after one season, indicate that the crop in these areas should be planted between the 17th and 28th January to do best and that yields well in excess of 600 lbs. per acre may be obtained provided the necessary care is taken in the planting and curing.

Flue-cured Tobacco

At the Lisasadzi Flue-cured Sub-Station, 80 miles from Lilongwe and in the Kasungu District, two trials were completed and a long term rotation experiment started.

Time of Planting and Fertilizer Mixture Trial.

The earliest planting on the 8th December gave a highly significant increase in both Yield and Grade Index over all later plantings and each time of planting was significantly better than all later times of planting.

The commercial " V " mixture gave a significant increase in Yield but not in Grade Index over the " K " mixture.

TABLE XIII

Response to Time of Planting for Flue-cured Tobacco

Time of Planting

	8th Dec.	*18th Dec.*	*29th Dec.*	*7th Jan.*	*L.S.D. (P=0.05*
Lbs./acre	1,209	637	504	188	184
Grade Index	25.3	13.3	8.0	3.0	3.6
Crop Index	30,588	8,472	4,032	564	—

TABLE XIV

Response to Fertilizer Mixture for Flue-cured Tobacco

N.P.K. ratio	*"V" (600 lbs./acre) 4–18–15*	*"K" (600 lbs./acre) 2–18–15*	*L.S.D. (P=0.05*
Lbs./acre	705	564	80
Grade Index	13.3	11.5	2.8
Crop Index	9,377	6,486	—

FERTILIZER AND GREEN MANURE TRIAL.

Ten fertilizer treatments were tried on tobacco, planted after each of three different green manure crops. Two of the green manures were split during their growing season so that half of each plot received 100 lbs./acre sulphate of ammonia while the other half received no fertilizer.

In the field, the tobacco after Natural Grass looked yellow in colour and appeared to need more fertilizer, while that planted after the Velvet bean green manure was vigorous looking, had a dark-green colour and tended to stay green when it should have been showing signs of ripening. That planted after Bulrush Millet appeared normal. The observations made in the field have been borne out in the analysis. The tobacco planted after Bulrush Millet showed itself to be a more economical crop in that the Crop Index (Value/acre) obtained was almost as high as that for the tobacco planted after Velvet beans and the number of lbs. of leaf to handle was very much less. The Grade Index (quality) being so much higher for the tobacco after Bulrush Millet accounts for this.

The addition of sulphate of ammonia to the Green Manure was not significant.

TABLE XV

Response of Flue-cured Tobacco to Planting after Different Green Manures, Two of which and a Part Fertilized and a Part not Fetilized

Green Manure

	Natural grass		*Bulrush millet*		*Velvet bean*		*L.S.D. (P=0.05)*
	Sulphate of Ammonia (lbs. per acre)						
	100	*nil*	100	*nil*	*nil*	*nil*	
Lbs./acre	661	689	1,065	1,163	1,422	1,492	183
Grade Index	22.8	25.6	27.4	26.8	22.7	22.8	3.5
Crop Index	15,071	17,638	29,181	31,168	32,279	34,018	—

Of the ten fertilizer treatments the two which included a side-dressing gave the highest Crop Index. Except for the first treatment there is not much to choose between the next three treatments in Table XVI each of which had much the same amount of P_2O_5 and K_2O. The low nitrogen applications have all given a low Crop Index, due not only to lower yields but also to slightly lower Grade Indices.

TABLE XVI

Response of Flue-cured Tobacco when N.P. and K. are varied

Fertilizer applied			*Yield lbs./acre*	*Grade Index*	*Crop Index*
At time of planting		*As side dressing*			
N	P_2O_5 K_2O *MgO*	*N* K_2O			
24–108–90	—	8–16	1,268	28.0	35,504
12–108–90	—	8–16	1,152	25.3	29,146
24–108–90	—	—	1,130	25.5	28,815
18–108–90	9	—	1,138	25.3	28,791
16–144–120	—	—	1,086	24.9	27,041
18–108–90	—	—	1,071	25.2	26,989
12– 72–60	—	—	1,059	23.8	25,204
12–108–90	—	—	973	23.6	22,963
12– 54–45	—	—	957	23.0	22,011
12–108–90	—	—	986	22.3	21,988
L.S.D. (P=0.05)		—	126	2.5	—

TUNG

1. Production of Improved Planting Material.

1.1. *Buddings versus Seedlings.*

Yields were lower than last year and the coefficient of variation had gone up from 24.7 per cent. to 27.6 per cent. Unselected seedlings remain the lowest yielders. There was no difference of the overall yield of clones worked on *montana* stock from the same clones worked on *fordii* stock. This appears to be due to the behaviour of the B-type clone F9 the yield of which, when worked on *fordii*, has gradually crept up since 1953 to a value far exceeding that on *montana*; on *montana* stock it is a poor yielder.

TABLE I

Buddings versus Seedlings, 1955

(*Yield in lbs. air dry seed per tree*)

Treatment	*Clones* M8	M13	H14	F9	*Mean*	*Mean excluding F9*
Montana stock	35.9	28.3	25.0	15.2	26.1	29.8
Fordii stock	28.4	32.3	18.9	24.5	26.0	26.5
Selected seedlings	23.1	23.0	17.5	11.8	18.9	21.2
Unselected seedlings (no clones)	—	—	—	—	15.7	—
Mean	29.1	27.9	20.5	17.2	—	—

L.S.D. for treatment means P=0.05,—7.37

„ „ Clones P=0.05,—4.21.

This season's results confirm those reported last year and it appears that *fordii* stock may have two possible effects on mature B-type tung: drought resistance and a capacity for the maintenance of vigour with age.

1.2. Clonal Trials.

Most experiments contain sub-plots and guard rows which are themselves clonal trials. Pressure of work has prevented a discriminating study of the old and new clones from being carried out. A field of new selections planted in December, 1947, has shown some high yielders which are worth recommending for new plantations or gapping up vacancies in old plantings.

TABLE II

New Selections. (*Planted* 1947)

(*Mean yield in lbs. air dry seed per tree*)

	Clone F225	G56	G108	G112	G96	G72	G87	G88	ES65	G43
Yield at 8 years (1955) ..	11.2	16.1	28.3	32.2	28.5	31.7	32.0	28.6	24.0	25.1
Mean 1952–55 ..	21.7	20.7	20.1	17.6	16.9	16.7	16.2	15.3	15.3	15.2
Yield per acre at 27′×27′ spacing	1,302	1,242	1,206	1,056	1,014	1,002	972	918	918	912

The above figures should be compared with those from a field, the oldest experimental field in Nyasaland, which contains a selection of well-known clones.

TABLE III

Original Selections. (Planted 1940)

(*Mean yield in lbs. air dry seed per tree*)

	Clones				
	M8	*14*	*10*	*N24*	*F9*
Yield at 8 years (1948)	15.7	24.6	25.7	13.9	11.2
Mean 1945–48	10.6	17.2	18.9	10.2	8.3
Yield per acre at 27′ × 27′ spacing	636	1,032	1,134	612	498
Mean yield per acre up to 1955	1,556	1,660	1,774	1,414	936

Most of the new selections are vigorous B-types; it is evident from the above tables that their performance most nearly compares with that of Clone 10 in the old selections, which gives a high yield in the early years and continues to yield well even when 15 years old.

A trial of crossed and selfed B-type seedlings planted in 1952 bore its first "fly" crop this year. Girth measurements show the most vigorous trees to come from the E464 × 14 crosses.

Girth measurements were taken of a two-year old trial on an estate of *fordii* buddings and seedlings of American origin, which is being compared with a standard *montana* clone.

Treatment	*Mean girth (inches)*
Montana Clone 10 on *montana* rootstock	6.98
U.S.A. *fordii* Seedling, Isabel, L2	4.63
,, ,, ,, , Lampton F578	5.76
,, ,, ,, , L152	5.25
,, ,, ,, , Gahl	4.59
L2 (Isabel) on *montana* rootstock	4.28
F578 on *montana* rootstock	3.33
L2 (Isabel) on *fordii* rootstock	3.31
F578 on *fordii* rootstock	2.85
Fordii seedlings ex Swaziland	6.31
Local *Fordii* Seedlings NZ5	4.41
,, ,, ,, NZ101	6.40
Low. Sig. Diff. P=0.05	0.81
P=0.01	1.06.

Girth measurements are an indication of vigour and the above figures show that the vigorous B-type *montana* clone is establishing itself better than buddings or seedlings of *fordii*. The best of the *fordii* selections are the local *fordii* seedlings (mother plant NZ101) and the *fordii* seedlings from selected plants in Swaziland, the former making most remarkable growth in height but a dangerously open-spaced branch system.

Fordii tung, although not so suited to Nyasaland climatically as *A. montana*, always holds a few attractions to some planters, the chief of which are its greater resistance to attacks by the *Armillaria* root fungus and its ability to keep going in the face of neglect. In response to local demand a field planted about 1940 has been regularly examined since 1950 and recorded since 1952; it has now been possible to reduce the number of 108 selections to 14 which have been put in two main groups:

(1) Mother cluster types and their progeny.

(2) Single fruited types and their progeny.

These may again be subdivided in the same way as *montana* tung, *i.e.* A-types which are vigorous with a pronounced leader, B-types which are less vigorous, usually more precocious and with no pronounced leader after the first year or so.

2. Cultural Practices.

2.1. *Intercropping and cover crops.*

An intercropping experiment, started in 1948, has been concluded with this season's results there was no significant difference in the treatments. The combined yields over the seven years of its life give the results tabulated below.

TABLE IV

Intercropping Trial

(lbs. air dry nuts)

	Treatment	*7-yr. yield per tree (all clones)*
M.	Intercropped with maize/soya alternate years	93.89
S.	,, ,, soya yearly	89.80
G.	Grass slashed twice yearly and slashings plus 1 lb. sulphate of ammonia applied as mulch	74.17
G.J.	Permanent cover of *Glycine javanica*	49.34
	Lowest Sig. Diff. P=0.05	7.76
	P=0.01	10.73.

Thus intercropping with a cultivated crop gives the best return from tung. Furthermore, the extra income from an intercrop such as soya should be taken into account when assessing the cost of maintaining a plantation. Trials, on the best method of planting soya and the varieties to grow, have been detailed in this Report elsewhere. For a purely labour-saving method Treatment G. is to be commended. Study of the yield by seasons will show a steady increase, due to the growth of the trees coupled with a biennial fluctuation, which can be related to seasonal rainfall variations.

TABLE V

Seasonal Yield per Tree *(irrespective of clones or treatment)*

1949	1950	1951	1952	1953	1954	1955	*L.S.D.* $P=0.05$	*L.S.D.* $P=0.01$
4.18 ..	6.22 ..	5.10 ..	16.32 ..	5.66 ..	27.22 ..	12.11 ..	1.01	1.33

In seasons of high yield treatments G., M. and S. were superior to the others, but in seasons of low yield G. was as good as or even better than M. and S.

It has been decided to conclude the experiment, due to the high number of vacancies (over 15 per cent.) caused by attacks of the *Armillaria* root fungus. The indigenous bush was not ringbarked and allowed to die before it was removed, a precaution that it is now known should be taken whenever any woody crops are to be planted.

Two new intercropping experiments have been planted, one at Bvumbwe and one on the Vipya. The treatments are being related to cost in the Bvumbwe trial.

2.2. Spacing Trial.

The spacing trial, described in lasty year's Report, has been planted in a field formerly planted to Rhodes Grass. The grass is being retained as an intercrop.

3. Fertilizer Trials.

3.1. *N.P.K.*

At Bvumbwe yields in this experiment were lower than last year and the coefficient of variation had gone up from 19.8 per cent. to 31.6 per cent.

TABLE VI

N.P.K. Factorial

(Yield in lbs. dry seed per acre)

Year	*Experimental mean*	*Increase in yield due to*		*L.S.D.*	
		Nitrogen	*Potash*	$P=0.05$	$P=0.01$
1954	1,822	316.3	18.2	91.2	121.9
1955	737	80.2	61.6	58.7	—

As usual 3 lbs. sulphate of ammonia per tree (170 lbs. per acre) produced a significant increase in the crop. For the first time on record there has been a significant response to potash, although for the past three years there has been a small positive response. This is the oldest N.P.K. experiment in the country (planted 1946) and it is quite possible that after a period of about ten years tung on soils which have on analysis been shown to be rather low in potash would need occasional applications of about 1 lb. per tree of muriate of potash. Such an application may be most important in years when rainfall is low, particularly during the winter months.

The experiment on the Vipya described in last year's Report still shows a highly significant response to Nitrogen. The coefficient of variation is less than last year but still high, being 32.8 per cent. of the General Mean.

TABLE VII

NP.K. Factorial (Vipya)

(*lbs. air dry nuts per acre*)

Experimental mean	*Increase due to sulphate of ammonia*		*L.S.D.* $P=0.01$
	1 *lb. per tree*	3 *lbs. per tree*	
889.2	104.8	150.9	99.7

3.2. N.P.K. with Copper and Zinc.

There are three experiments. The two, at Bvumbwe and Mzuzu, show no clear cut responses to any treatment. The third, near Zomba, shows a highly significant response to nitrogen. The application of zinc is obviously beneficial by the appearance of the trees so treated although in the analysis it just misses significance. There is some dieback in the plots most markedly where potash has been applied; phosphate has no beneficial effect.

TABLE VIII

N.P.K. with Copper and Zinc (Gala)

(*Yields in lbs. dry seed per acre*)

Experimental mean	*Treatment effect over mean*				*L.S.D.*	
	N	P	Z	PK	$P=0.05$	$P=0.01$
801.7	+184.8	−141.2	+70.4	+76.5	79.5	107.2

3.3. N.P.K. with Dung.

Yields for an experiment near Zomba were not quite as high as the previous year and about half that of 1952. The yield appears to be closely linked with rainfall (see note on biennial bearing). Treatment effects are shown in the Table below.

TABLE IX

N.P.K. with Dung Trial (Gala)

(*Yield in lbs. dry seed per acre*)

Experimental mean	*Treatment effect over mean*						*L.S.D.*	
	N	P	D	PD	NP	ND	$P=0.05$	$P=0.01$
606.3	+240.3	+23.7	+113.3	+56.2	−26.4	+11.8	77.2	103.2

Three lbs. sulphate of ammonia per tree still gives a very significant increase in the crop, the effect being about the same as last year. One hundred lbs. dung per tree also gives a significant increase in crop (at 1 per cent. level) but no other treatment or interaction gives any significant increase or decrease. The effect of 3 lbs. superphosphate per tree is negligible and although the soil analyses, taken at the beginning of the experiment, showed a low phosphate status, there seems to be no justification for its application. In this experiment, dieback was noticed to be serious in one or two plots; trees suffering most seem to follow the line of a badly eroded gulley and those which had potash dressings seem to be in the worst condition.

3.4. Nitrogen.

The overall yield of the experiment running at Bvumbwe was less than half of that obtained last year with, as a result, a very high coefficient of variation. All levels of nitrogen gave a significant increase over none.

TABLE X

Nitrogen Fertilizer Trial (Bvumbwe)

(*Mean yield lbs. dry nuts per tree*)

Rate per tree of sulphate of ammonia				*L.S.D.* $P=0.05$
6 lbs	*4 lbs*	*2 lbs.*	*Nil*	
20.1	18.5	18.4	12.3	6.7

The effect of nitrogen, applied to young growing trees, can be seen within one season after the application although no level of significance is yet reached. Sulphate of ammonia produces a quicker response than tung cake.

TABLE XI

Nitrogen Fertilizer Trials

Treatment	*Control*	*Tung cake lbs. per tree*		*Sulphate of ammonia lbs. per tree*					*L.S.D.* $P=0.05$
	0	T.20	T.30	*N6/2	N2	N6	*N4/2	N4	
Yield air dry nuts per tree (Gala)	4.9	4.1	4.7	5.5	5.8	6.2	6.3	7.5	2.1
Girth inches/tree (Nchima) ..	2.2	2.6	2.9	2.8	2.9	3.1	3.0	3.0	Not sig.

**Split applications.*

4. Other Tung Experiments.

4.1. *Biennial Bearing.*

Studies on the biennial bearing habit of tung continue. A theory of the causes of the habit and possible means of correcting it was outlined. (See Reference 1.) The small experiment initiated at the end of 1953 with the treatments below has now passed through an "on" and an "off" period:

(*a*) Apply a double dressing (6 lbs./tree) of sulphate of ammonia in the "on" year and none in the "off" year,

(*b*) Remove half the flower buds per tree at the beginning of the growing season in the on year,

(*c*) Combination of (*a*) and (*b*),

(*d*) No Treatment (Control), and

(*e*) Apply a leaf-damaging spray in the "off" year.

The mean yields and growth per plot were as follows:

TABLE XII

Plot	(*a*)	(*b*)	(*c*)	(*d*)
Yield, 1952	20.1	8.0	12.7	16.6
Yield, 1954	36.2	30.6	22.3	30.5
Yield, 1955	10.5	6.5	6.1	6.7
Mean growth 1954	18.1	20.0	17.9	21.1

The yield figures for 1952 and 1954 were for " on " years. The growth 1954 and yield 1955 figures were taken at the end of the growing season after treatments " *b* " and " *c* " had been carried out. There is no significant difference between any two treatments. It thus appears that de-blossoming in the " on " year did not influence the trees to make more productive growth the following year; neither did it appear to reduce the yield in 1954. Treatment " *c* " was to have been a spray of D.N.O.C. The material did not arrive until December, 1954, when it was applied at a strength of 3 per cent.; this was, however, too late to be of value.

In view of the negative results obtained in this experiment it was necessary to look further for the factors causing biennial bearing. A more detailed study of the rainfall figures showed a significant correlation coefficient between total rainfall for the months June to August and crop for the following year. (See Reference 2, to which collaboration with the Tea Research Station is acknowledged.) The rainfall for the period June to August, 1954, was just below the ten-year mean and the crop could be expected to be on the low side. This in fact was the case.

TABLE XIII

Rainfall and Yield of Tung

Year	1947	1948	1949	1950	1951	1952	1953	1954	10 *year average*
Rainfall June to August ..	1.25	1.97	2.57	1.63	2.54	0.68	2.96	1.93	1.94
Yield in the following May ..	1,019	1,384	2,363	1,249	3,102	914	2,281	969	1,475

The rainfall for June to August, 1955, was 1.14 and thus a low crop can be expected in 1956.

In order to test this theory records are being kept of three additional plots:

(i) Soil covered with roofing material to keep off any natural rain that may fall between June and August,

(ii) Irrigate artificially, bringing up the amount of water received to 1.50" per month, June to August inclusive, and

(iii) Natural Rain.

Records of the yields of the plots will be taken.

Soil moisture contents taken at the end of August gave the following figures:

Plot	*Depth* 0–3"	6–9"	3' 0"
i	4.4	11.5	20.0
iii	4.5	9.1	19.1

There are no differences of importance between plots (i) and (iii), since the rainfall during the three months under review was unusually low; plots (i) was slightly moister than plot (iii), apparently due to the slight screening effect from drying winds of the framework made to hold the roofing material.

A detailed study of flower buds during this period would have yielded some valuable information, since this is the time that flower primordials are laid down. There was, however, insufficient time, staff or facilities to pursue this matter further.

References

(1) Foster, L. J.—An Hypothesis for Biennial Bearing in Tung. *Nyasaland Farmer and Forester*, Vol. 2. No. 4, May, 1955.

(2) Laycock, D. H. and Foster, L. J.—Rainfall and Biennial Bearing in Tung. *Nature*, No. 550.

5. Pests and Diseases of Tung.

The dieback disease *Botryosphaeria ribis* continues to take its toll, particularly in neglected plantations. Two small trials, carried out with Dithane spraying in 1953 and 1954, gave poor control of the disease.

In the first trial two blocks of 70 trees each were earmarked, one block being sprayed on 8/10/53 and 24/12/53 and the other receiving no treatment. A count made on 21/2/54 of fresh infections as measured by wilting or death of growing shoots gave the following results:

	No. of trees freshly infected	*Total fresh infections*
Sprayed plot	40 ..	264
No treatment	50 ..	310

Thus it seems that spraying was not very effective

For the second trial eight 4-tree plots were chosen. All infections were pruned out and burnt on 3/9/54. Three sprayings with Dithane and Karathane WD were then carried out at fortnighly intervals in late September/October—a time when infection is most likely. In the following March, 1955, all trees were pruned where dieback could be seen. The number of prunings per tree was counted and the total prunings weighed.

Treatment	*Mean number prunings/plot*	*Mean weight prunings/plot*
Sprayed with Dithane	77.0 ..	28.0 lbs.
Sprayed with Karathane WD	81.5 ..	47.0
Not sprayed	94.8 ..	44.1

The evidence is therefore insufficient to show that the spray materials used had any control over *Botryosphaeria*.

The root disease *Armillaria mellea* ties with *Botryosphaeria* as the most important disease of tung. Attempts were made to control attacks on infected trees by exposing the infected area of root and trunk, cutting out the diseased portions and applying a protective covering of Bordeaux mixture paint, but of seven trees so treated, five still showed infection 12 months later. This disease has also attacked *Sesbania* shade trees in coffee and peach trees.

Tung Thread Blight, *Corticium solani*, attacked the foliage and young shoots of tung seedlings in the nursery. The disease was controlled by spraying with a 4:6:50 strength of Bordeaux mixture. Leaf spot, *Glomerella cingulata* was fairly widespread.

Fusarium lateritium was reported on tung on the Vipya; it was not severe enough to warrant control measures. But a strain of this disease causes serious dieback of coffee. As tung growers are tending to make small-scale plantings of coffee in tung, the relation between strains of the disease must be carefully studied.

Bark splitting occurred on tung at Mzuzu. It was restricted to the higher ridges of the area where the trees received little protection from the wind and sun. A-types, the branches of which do not shade the trunk as effectively as B-types, were most affected.

Attacks of scale insects were fairly widespread; white ants were reported as causing losses of tung trees in the field near Cholo.

Isolated cases of the borer beetle, *Apate indistincta*, were reported from the Vipya, mostly on trees growing in unfavourable conditions.

EXTRACT FROM AGRICULTURAL CHEMIST'S REPORT

A. Exported Oil.

Tung Oil—In the period under review 31 samples from 600 tons of oil were examined. This was evenly distributed in 200 ton lots to Africa, Europe and the United States of America. A small consignment of *Montana* and *Fordii* oil was sent to Sweden, where one company had expressed interest in commencing activities in the Federation. Only three consignments from the 1954/55 crop, totalling 115 tons have been dealt with.

Owing to shortage of drums, one factory had to cease expelling for an appreciable time, during which some of the accumulated seed became wet. This led to 50 tons of oil having an F.F.A. of 8 per cent. However, this was satisfactorily disposed of without difficulty.

B. Seed from Portuguese East Africa.

One of the factories was offered 900 tons of seed from Portuguese East Africa from the 1954 crop and 600 tons from the 1953 crop. Samples of these seeds were examined in order to assess the practicability of buying this seed. Both years' seed were similar— 15 per cent. having broken shells, or otherwise being damaged and considered unsatisfactory. Of the apparently good seed, 50–60 per cent. were found to contain mouldy kernels when the shells were opened. Although the good seed gave an oil of satisfactory acidity (1.5 per cent.) the mouldy seed gave oil having an acidity of 6–9 per cent. As it would be impossible to hand pick mouldy kernels, the resultant oil from all the seed would have an acidity of approximately 5 per cent. Bearing in mind that with mechanical expelling, the acidity of the oil will be more than that found by solvent extraction, an acidity of probably 10 per cent. would have to be faced. In view of the difficulty in disposing of large quantities of rather acid oil, the prospects for the Portuguese East Africa Seed seemed very hazardous.

C. Diseases.

The instance in the Southern Province of premature fruit fall, reported last year, did not seem due to any morphological factor in the soil and after a survey of the whole estate it was apparently due to a clonal characteristic.

In March, 1955, the Vipya tung estates reported early leaf fall and scorch. In view of last year's finding, leaf analysis was made but no marked differences between the good and bad leaves was observed. The scorch was, however, associated with yellow halations, which were identified as due to *Mycosphaerella* sp. It may be of some significance that the worst scorch and leaf fall occurred on the oldest plantings at Lusangazi and Mazamba.